SCIENCE

FRIDAY, AUGUST 5, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE FUTURE WHEAT SUPPLY OF THE UNITED STATES[1]

THE subject of our future wheat supply is seen at once to involve four separate questions, as follows: (1) What is the possible increase in production that may be attained? (2) How may it be attained? (3) What is the probability of such attainment? (4) Will this production satisfy the demand?

It is evident also that no tangible benefit can come to the reader of any discussion of this subject which does not have application to some definite period of time. It is assumed, therefore, in this present discussion that we are concerned with movements in the next forty years—or a period closing with the year 1950.

POSSIBLE INCREASE IN WHEAT PRODUCTION

An increase in wheat production can arise in two ways: (1) By an increase in the wheat acreage, and (2) by an increase in acre yields.

INCREASING THE WHEAT ACREAGE.

The wheat acreage may be increased through an expansion in the farm area and also by devoting a larger percentage of the present farm area to wheat.

Expansion of the Farm Area.—The total land area of the United States is 1,900,947,200 acres. By the census of 1900 it was shown that at that time 44.1 per cent. of this area, or 838,591,774 acres, was included in farms. The farms were of all sizes, and of course were not entirely cultivated, many of them in fact, being large

[1] Read before the Millers' National Federation Mass Convention at Minneapolis, June 22, 1910.

stock ranges. The following table shows a rapid development from 1850 up to that time, and gives the total farm acreage, the improved farm acreage and the wheat acreage for each census year that they were determined, also the percentage each of these comprises of the total land area.[2]

Year	Farms		Improved		Wheat	
	Acreage	Percentage	Acreage	Percentage	Acreage	Percentage
1900	838,591,774	44.1	414,498,487	21.8	41,971,000	2.2
1890	623,218,619	32.8	357,616,755	18.8	37,275,000	2.0
1880	536,081,835	28.2	284,771,042	15.0	31,912,000	1.7
1870	407,735,041	21.4	188,921,099	9.9	18,386,000	1.0
1860	407,212,538	21.4	163,110,720	8.6	15,424,496 [3]	.8
1850	293,560,614	15.4	113,032,614	6.0		

Since 1900 there is no definite statement of farm acreage. A fair estimate can be made, however, for the present year. The "yearly disposal of public lands for cash" for the period 1900–1908 amounted to 164,-159,599 acres. Practically all or nearly all these lands go into farms.[4] Lands similarly disposed of in Texas, according to the reports of the commissioner of the Texas general land office, amounted to 22,-470,856 acres from September 1, 1900, to August 31, 1908. Considering now the later additions from these two sources, together with the large tracts of railroad lands sold to new settlers in recent years, particularly in Kansas, Nebraska and Colorado, it appears that at least 200,000,000 acres have been added to the farm area since 1900. This would make the total farm area for 1910 about 1,050,000,000 acres, or approximately 55 per cent. of the total land area. If so, the increase is greater than in any other decennial period except the preceding, 1890–1900.

The question then is, how much additional farm area may be expected in the future. Certainly not a great deal, but I believe much more than many suppose. Again the amount may be estimated, but this time more roughly, and the area may not be fully occupied for many years.

According to the Report of the General Land Office for 1908, there were at that time, exclusive of Alaska, 386,873,787 acres of government lands "unappropriated and unreserved." Though these lands include all kinds, agricultural, grazing, mineral, etc., surveys and estimates of state officials make it probable that 75,000,000 to 100,-000,000 acres will be included in farms. There will be other additions from present Indian reservations. At the close of the fiscal year 1908 there were 52,013,000 acres of Indian lands "unallotted and unreserved," and these are generally better than the usual run of western lands.[5] We are apt to overlook also the large amount of

[2] The facts are taken from the Statistical Abstract of the United States, pp. 119–121, except wheat acreages, which are calculated as ten-year averages from regular reports of the Bureau of Statistics, U. S. Department of Agriculture. For the census years of 1880, 1890 and 1900, averages for the periods 1874–1883, 1884–1893 and 1894–1903, respectively, are employed, and for 1870 the average for the period 1866–1871, as the figures for wheat acreage in this period do not go back farther than 1866.

[3] This sum is the acreage for 1866.

[4] They include original homestead entries, as much the larger portion, timber culture claims, lands obtained with agricultural college and other scrip and under military bounty land warrants, and lands (a comparatively small amount) selected by states and railroads. (See Statistical Abstract of United States, pp. 24–25.)

[5] See Report of Commissioner of Indian Affairs, 1908, pp. 149–164.

swamp lands in the United States that may be reclaimed and used in profitable agriculture. The total area of these lands is over 79,000,000 acres.[6] Wherever these lie in the wheat districts they may be so drained as to be profitably used for wheat, as the nature of the soil will be such, no doubt, that they will be very productive. Add to all these figures the natural expansion of farm area in the older states, which amount will hereafter be proportionally greater than heretofore, and it seems reasonable to expect 250,000,000 to 300,000,000 acres of additional farm area even in the next twenty-five to thirty years. By 1950, therefore, the most conservative estimate would make the total farm area of the United States more than 1,300,000,000 acres, or about 70 per cent. of the total land area.

The improved farm area has heretofore been about half of the total farm area, but will hereafter increase more rapidly than the latter. By 1950 it should therefore reach at least 40 per cent. of the total land area, or about 760,000,000 acres.

Percentage of Farm Area in Wheat.—The percentage of total farm area employed for wheat has been as follows: In 1870, 4.5 per cent.; in 1880, almost 6 per cent.; in 1890, practically the same as in 1880; and in 1900, 5 per cent. At present it is approximately 4.8 per cent. The average proportion to date has been, therefore, 5.2 per cent. This percentage of the future possible farm area would be over 69,000,000 acres, or 22,000,000 acres more than the acreage of 1909. That is the amount of future wheat acreage that is entirely possible, simply on the basis of an increase in farm area up to 1,330,000,000 acres.

Increase of Wheat Acreage within the same Farm Area.—There is hardly a doubt, however, that the percentage of farm area devoted to wheat will itself increase. Previously there was a period when the proportion was almost 6 per cent., but which was followed by a period of great wheat depression in the nineties. Then, even after a revival in wheat acreage, the proportion of farm area thus employed continued decreasing because of the tremendous increase in the number of farms

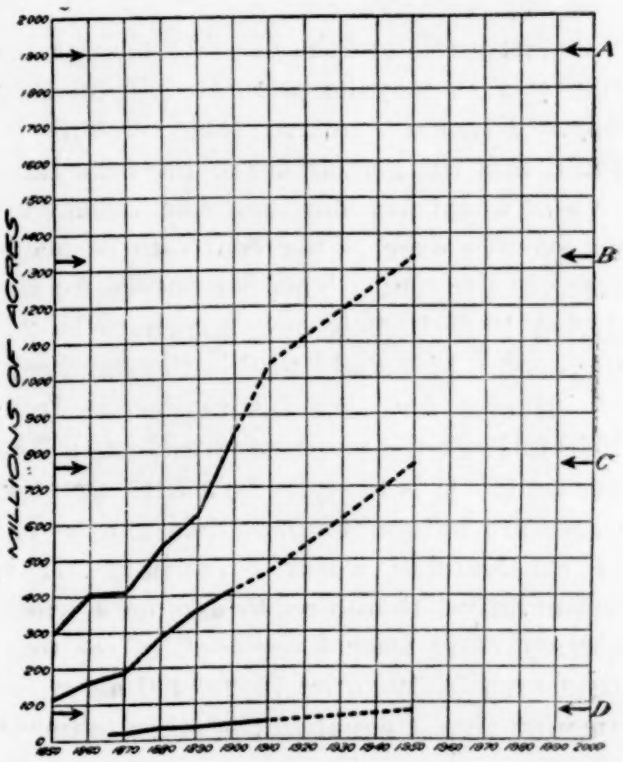

FIG. 1. Diagram showing increases in farm area (upper line), in improved farm area (middle line) and in wheat acreage (lower line) that may occur by 1950, conservatively estimated. *A*, absolute limit of land area; *B*, probable farm area in 1950; *C*, probable improved farm area in 1950; *D*, probable wheat acreage in 1950.

toward the end of the century. Already the percentage is again increasing, from nearly 4.5 per cent. in 1909 to 4.8 per cent. in 1910. Long before 1950 the proportion should easily reach 6 per cent. again, both because of probable wheat expansion due to increase in prices and because the farm

[6] Senate Document No. 443, Sixtieth Congress, first session.

area will hereafter increase less rapidly. Much of the increase in wheat acreage will occur in the older states, this being now true for the year 1910. We have for the first time reached the 50-million mark, the acreage this year being 50,500,000 acres. In 1950 at the rate of 6 per cent. on a farm area of 1,330,000,000 acres, our wheat acreage should be about 80,000,000 acres. The accompanying figure illustrates the conditions that may exist by 1950, based upon conservative estimates.

An estimation of the possible wheat acreage by 1950 may be calculated in another way. From the above table it will be noted that the percentage of the total land area in wheat has increased each decade on an average over .3 per cent.—to be accurate, .34 per cent. This percentage for the period 1900–1909 is now known to be 2.5 per cent. If we add to this the same rate of increase for each future decade from 1910 to 1950, the percentage will reach 3.86 per cent. It is likely to be a little greater, as we are no doubt now entering a period of considerable wheat expansion. It is conservative, therefore, to assume a wheat acreage of at least 4 per cent. of the total land area in 1950, or 76,000,000 acres, an amount almost equal to the other estimate.

INCREASE IN PRODUCTION ON THE SAME ACREAGE

An erroneous opinion has widely prevailed for some time to the effect that the yield of wheat to the acre in the United States is decreasing. On the contrary, there has been a considerable increase, amounting to 1.8 bushels in the past forty years. Considering the past thirty years, only, the increase has been fully 2 bushels per acre, the yield during the second decade having been less than that of the first. It is really more accurate, however, to calculate from this second decade of 1880–1889 than from the first, as it was during the second period that the great extension of the wheat area into the great plains and western mountain states occurred, and hence it was only by this time that average yields would fully represent the entire country. Two bushels increase on each of 46,678,400 acres, the present average wheat acreage, equals over 93,000,000 bushels, which is the present increase in production over what it would be at the acre yield prevailing thirty years ago. The present average yield is 14.1 bushels. At the same rate of increase above mentioned, this yield should increase to 16.8 bushels in 1950.

It must be remembered, however, that each decade there is a much more rapid diffusion of knowledge of improved methods of culture, seed selection, use of better varieties, etc., and all farming will become constantly more intensive. An actual increase in acre yield, therefore, of six bushels by 1950 ought to be a fair estimate, thus raising it to 20 bushels. At this acre yield the 80,000,000 acres of wheat in 1950 would produce 1,600,000,000 bushels.

MEANS OF INCREASING ACRE YIELDS

The increase of 2 bushels in yield per acre attained during the past thirty years has resulted without question through certain improvements in wheat culture, as the soil and climate have probably become at least no better. The means of accomplishing these improvements are chiefly three: (1) the introduction of better adapted varieties, (2) hybridization and selection in existing varieties and (3) better methods of cultivation.

Introduction of New Varieties.—Up to the present time by far the greatest improvement has been made through the introduction of new wheats. As early as 1819 the U. S. Department of Agriculture imported the Mediterranean, a semi-hard winter wheat, which was afterwards so

commonly grown in southern Pennsylvania, and in more recent years has been the popular wheat of northern Texas. The Sonora from Mexico and the Australian from Australia are good examples of introductions into California and the southern Rocky Mountain states, which became afterwards important standard varieties.

The great introductions, however, that have been revolutionary in their influence on the wheat industry of this country, and have made landmarks in history, are those of the Fife brought from eastern Europe through Scotland and Canada into the northern states of the plains, and the Crimean or Turkey brought from the Crimea and established in the middle states of the plains. The combined output of these two types of wheat now comprises nearly half the entire wheat production of the country. These introductions have in each instance been the foundation of an enormous milling business, and have without doubt added to the wheat production of the two areas combined 40 to 60 million more bushels than would have resulted from the use of other wheats previously grown. New introductions may increase wheat production by increasing both the wheat area and the acre yield. Often better adapted varieties will make their way into new localities where the conditions are so severe that other wheats would not usually succeed. This has been true in the introduction of the Crimean wheats into the middle states of the plains, both at the beginning and in later introductions of hardier strains. A particularly good example is that of the Kharkov strain introduced by the U. S. Department of Agriculture, which now furnishes an annual addition of at least 20,000,000 bushels of the present hard winter wheat production by extending the area to the north and west and by increasing the acre yield.

Similar to the influence of the Crimean wheat introduction has been that of the durum. Here we have the best example yet known of adaptation to severe conditions. By penetrating localities so dry that other wheats would not survive, and by an increase of acre yields from 20 to 50 per cent., the introduction of this type of wheat has added about 30,000,000 bushels annually to the wheat production of the great plains.

One of the best examples of improvements yet possible is found in the conditions surrounding the grain grower and miller in California. The wheats commonly grown there, Australian, California Club and Sonora, are very deficient in gluten usually, though there is considerable variation in this respect in varieties and localities. To comply with the demands of the flour markets, therefore, the miller imports wheat of greater baking strength from the hard wheat areas of the great plains to the extent of nearly or quite half of all he uses. This condition is in face of the fact that California *can* produce all the wheat she needs and has done so formerly. As early as 1878 the production was nearly four times that of the present. While bad practises of cultivation are largely responsible for present low yields, there is great need of new varieties in general cultivation, giving better yields and better flour.

It is pleasant to be able to announce here that exactly the varieties for these purposes have been found, and only an increase in the seed is now needed to give California a wheat ranking well in commercial quality with any other in the country. These varieties are the Chul and Fretes, introduced by the U. S. Department of Agriculture from Turkestan and Algeria, respectively. They not only stand high in quality, but yield much better than any of the native wheats. Chul

appears to be a little the best. With the general use of these wheats and better farming operations it will be easy to raise the production in California to the old-time figures of 40,000,000 bushels, by making wheat growing profitable.

Improvements in Existing Varieties.—Both the native and introduced wheats are capable of being greatly improved by continuous selection of the best individuals and by hybridization with each other. This work is practically in its infancy, though considerable progress has been made. Some of the best known new wheats produced by hybridization are those originated by A. N. Jones in New York, one of which, Jones's Winter Fife, is widely grown. Mr. Pringle, of Vermont, also produced several new wheats of importance, the well-known Defiance, a spring wheat, being the best.

Of selected wheats, the one most commonly grown to-day is the Fultz, developed by Abraham Fultz in Pennsylvania. It is now a standard variety in all winter wheat districts, though being rapidly supplanted in some localities by hardier sorts. The selection work done at the Minnesota Experiment Station, resulting in the new strains, Nos. 163, 169, etc., has had the greatest influence of all work of this kind on wheat production, and has greatly increased the spring wheat yield. Much of this improvement has been accomplished in cooperation with the U. S. Department of Agriculture.

Improvements in Methods of Farming.—There is no doubt that much of the increase in acre yields already attained is due to improved farming methods. Yet improvements in this line are only fairly begun. The size of farms will continue to be curtailed, and operations will become more careful and intensive. The wheat acreage may thus be slightly lessened in some places, but this will be more than counterbalanced by better results from each acre. More complex and better adapted systems of farm management are being adopted, which require careful rotations of crops, better tillage and use of waste products.

Recent interest in "dry farming," so-called, is resulting in a rapid diffusion of the knowledge of proper methods of cultivation for conservation of moisture. There will grow out of this a considerable further increase in yield in the dry districts and a further extension of the wheat area into localities still drier, where agriculture in general is now considered to be at best very uncertain. It may be of interest to the millers to know that the U. S. Department of Agriculture has under way extensive series of experiments in just this line of investigations at fourteen points in the western great plains and intermountain districts. Hundreds of dry-land wheats also are being studied and selected on these farms.

The use of legumes and other crops to be plowed under green to furnish more humus and as renovators of the soil in other respects will be much practised hereafter. In the course of a series of experiments conducted several years in California, by the U. S. Department of Agriculture, part of the time in cooperation with the state experiment station, it has been found that one of the greatest needs of the wheat grower is the use of leguminous crops for the purposes just mentioned and the practise of sowing wheat after green rye plowed under. The yield of wheat per acre following these treatments of the soil was 22 bushels greater than that of wheat following wheat.

Probability of Increase in Production

We come now to the question which, after all our efforts with estimates, is the most difficult to answer. What is the

probability that the great increase in wheat production through increases in the acreage and in acre yields that are entirely *possible,* will be *realized,* either in whole or even in large part? In fact, it can not be answered definitely. That which is possible may not be at all probable. One can risk an opinion, however, on the basis of the facts at hand, and in the present case the chances seem strong that something near the increase in wheat production previously discussed will be realized. There are two good arguments that may be used in support of this opinion. The first is deduced from the facts of past conditions. It is almost an axiom in common philosophy that the trend of events in future over a long period of time will be about the same as in the past.

WHEAT EXPANSION AND DEPRESSION

In the past the tendency in most movements has been both upward and downward in wave-like motion, crest following depression and depression following crest, though on the whole there may have been advancement. The movement of wheat acreages and prices has followed this rule, and, therefore, it is reasonable to suppose, will continue to follow it. These wave-like movements are often complicated by the fact that many small ones may be involved within one large one. A careful study of the course of wheat acreages and prices in this country for the past forty years will nicely illustrate these statements.

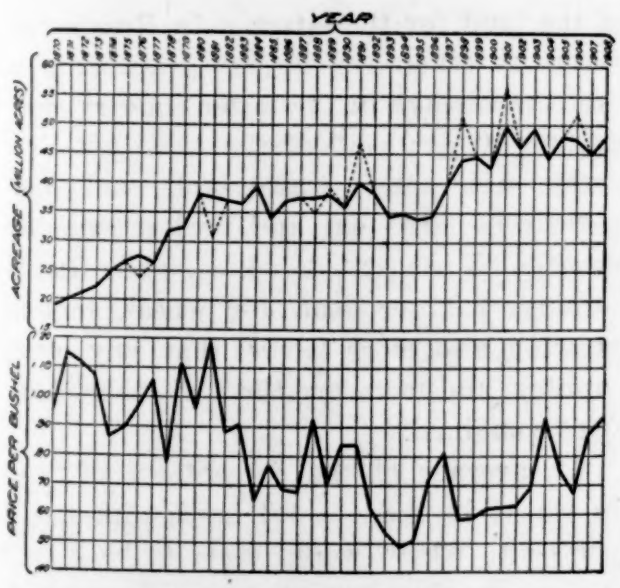

FIG. 2. Diagram showing variations in wheat acreage and prices for 39 years, from 1870 to 1908. The upper line represents the trend of wheat acreage (in millions of acres) and the lower that of prices (in cents per bushel). From left to right are shown the different years.

Almost constantly large wheat acreages and accompanying low prices have been followed by diminished acreages and accompanying high prices, and so on. An unusual period of wheat expansion occurred during the years 1881 to 1892, followed by a period of great depression in 1893–96. During both these periods and since 1896 many minor movements up and down occurred. We are now apparently entering a period of considerable wheat expansion, and naturally enough prices are falling. It is simply the old question of supply and demand. The farmer can not be blamed if he grows what is most profitable. If the demand is great, and prices increase, and wheat growing is profitable, the farmer will grow wheat. It was simply in recognition of this general principle that Mr. Patten and his associates over a year ago, foreseeing a necessary rise in prices, were able to make a good "clean-up"; but it was not the fault of this same principle when, a year afterwards, the same parties, turning too late from the oncoming wave-crest of wheat, were caught and a good portion of their previous gain washed away.

The final result of the up-and-down movement to date has been a greatly increased wheat production. It is reasonable, therefore, to expect the same thing

in future, but we shall also experience similar temporary fluctuations.

ANALOGIES FROM CONDITIONS IN OLDER COUNTRIES

The opinion that a constant increase in production will continue in future and that the foregoing estimate of the amount of this increase is very conservative is greatly strengthened through reasoning by analogy from conditions now existing in older countries. Some of these countries are now at the stage of development in agricultural resources that this country should not reach for many years. Therefore the conditions as to supplies of different crops existing in those countries to-day should give us an approximate idea of what we may expect.

PERCENTAGE OF TOTAL LAND AREA IN WHEAT

Mention is made above of the method of estimating the future wheat production from the gradual but constant increase in the percentage of total land area heretofore employed for wheat, and it is stated that 4 per cent. should be a conservative estimate of the proportion of total land area that will be so employed by 1950. Statistics of other countries appear to show by comparison that such an estimate is very mild. The following figures give the percentage of total land area now being employed for wheat in a number of important countries.

Country	Percentage of Total Land Area in Wheat	Country	Percentage of Total Land Area in Wheat
United Kingdom	3.1	Japan	1.2
Austria	3.7	Netherlands	1.8
Hungary	11.2	Roumania	14.5
Belgium	5.1	Russia (European)	3.9
Bulgaria	8.4	Servia	7.5
Denmark	1.0	Spain	7.3
France	12.3	Argentina	1.9
Germany	3.5	British India	4.9
Italy	16.5	Manitoba	6.6

It is seen that the percentage in other countries runs from 1 per cent. in case of Denmark to even 16.5 per cent. in case of Italy. Spain is considerably mountainous, but employs 7.3 per cent. of her total land for wheat. Hungary uses 11.2 per cent. The United Kingdom, though not naturally a wheat country, practising greatly diversified farming and having much meadow land, yet devotes 3.1 per cent. of her land to wheat—.6 per cent. more than the proportion we now employ. It may be objected that our immense corn crop must be considered, absorbing a large area which in other countries can be given to wheat, also that in importing countries, like Italy and the United Kingdom, the insufficiency of supply itself furnishes a stronger incentive for wheat growing. This argument, however, is of no use, for Roumania has a large wheat export in proportion to her size, grows three times as much corn per square mile as the United States, yet devotes 14.5 per cent. of her land to wheat. Servia, though growing much more corn than wheat, nevertheless employs 7.5 per cent. of the land for the latter. In Russia and Germany much the largest grain crop is rye, the acreage in the latter country comprising 10 per cent. of the area; yet Germany, with much waste land, and comparatively large oat and barley acreages, devotes 3.5 per cent. to wheat, while Russia employs 3.9 per cent. for wheat, though growing also more barley than any other country, and more rye than all other countries combined.

An average of the percentages of land in wheat in these countries is almost 6.4 per cent., which would seem to be a fair indication of the proportion of our own land that may be sown to wheat many years hence, provided there is sufficient demand. That percentage would give us approximately over 120,000,000 acres, or 25,-

000,000 more acres than are now given to corn, and much more than twice the present wheat area.

ACRE YIELDS IN OTHER COUNTRIES

Statistics of other countries show also that the limit of possible yield per acre of 20 bushels previously estimated for 1950 is much below what has been attained elsewhere. Germany now produces 28.7 bushels of wheat to the acre, while in the United Kingdom the average is 32.6 bushels (Winchester). In France the acre yield is 20.4 bushels.

RECENT INCREASES IN OTHER COUNTRIES

To show that increases in area and yield may go on in later years, it should be noted further that much recent progress has been made in other countries. For example, in Hungary, one of the oldest wheat countries, the acreage has increased even since 1884, from 6,797,800 acres that year to 9,474,415 acres in 1908. In European Russia it has increased from 39,711,200 acres in 1894 to 62,766,700 acres in 1908. In smaller countries the acreage increases have been as follows: Roumania, 2,903,700 acres (1886) to 4,452,000 acres (1908); Bulgaria, 2,167,200 acres (1897) to 2,422,700 acres (1908); Servia, 783,500 acres (1893) to 931,300 acres (1908).

Likewise have the acre yields increased. In the United Kingdom, where farming is so intensive that it would seem hardly possible in late years to get anything more from the soil, nevertheless, the yield has increased during the past ten years almost 2 bushels. In France it has increased over 2 bushels in the same period, in Austria 3 bushels, and in Germany the astonishing amount of 5.2 bushels.

WILL FUTURE PRODUCTION EQUAL OR EXCEED THE DEMAND?

Future demand, of course, depends upon the population and per capita consumption. At the outset, it may be remarked that the increase in our future population, as stated by some parties, appears to be much over-estimated.

The census population figures for continental United States show that, starting with an increase of nearly 12,000,000 from 1870 to 1880, the succeeding increases have been rather constantly about 1,000,000 more for each ten years than for the preceding ten years. At this rate of gain, beginning with a commonly estimated population of 90,000,000 for 1910, this being an increase of 14,000,000 over that of the preceding census, the figures for 1950 should be about 156,000,000. Allowing for a considerably higher rate of increase, however, we may, for safer calculation, assume it to be 160,000,000.

The home consumption of wheat per capita in this country, including seed and wheat flour (at 4½ bushels per barrel), has been as follows: 1870, 5.02 bushels; 1880, 5.52 bushels; 1890, 5.49 bushels; 1900, 5.11 bushels. The same is estimated to have been about 6.39 bushels in 1906 and 6.34 bushels in 1908. There has been much fluctuation, and the figures may settle at about 6 bushels for 1910 or perhaps more. Anyway, there has been apparently an increase of about 1 bushel in our per capita consumption since 1870. We may suppose an equal increase in the equal period of the next forty years, making 7 bushels for 1950, though it may be considerably less.

At the rate of 7 bushels per capita a population of 160,000,000 will require 1,120,000,000 bushels of wheat. This amount taken from the production of 1,600,000,000 bushels above estimated for that year, and which is shown to be very conservative, leaves a surplus of 480,000,000 bushels. Some predictions of our future population have placed it much higher than 160,000,000 for 1950, one making it as high as 200,-

000,000. Supposing this last to be correct, at 7 bushels per capita, that population would require 1,400,000,000 bushels, leaving still a surplus of 200,000,000 bushels. Again, if we assume that there will be a greater increase in per capita consumption resulting in as much as 8 bushels by 1950, the amount required at home at this rate would be 1,280,000,000 bushels, leaving a surplus of 320,000,000 bushels. Supposing both contentions of the larger increases in population and consumption should be true, which is extremely improbable, the demand would just equal the supply.

POSSIBLE INCREASE IN PRODUCTION IN OTHER COUNTRIES

A complete view of the situation as to future wheat supply requires some consideration of world production, even though our own production may be more than sufficient for home demand. Except in unusual instances, prices, export, etc., are affected by world conditions. It is an important question whether we may continue to expect an occasional surplus in the world's crop.

There are only three regions that, for many years, will have any considerable part in furnishing a world surplus. All other countries will, at most, no more than supply themselves. These regions are (1) the plains of North America; the "black earth" of eastern Europe and including a large indefinite area in Siberia, and (3) Argentina.

The most important of these regions, for the present, is in North America, and a large part of it lies outside of the United States in Canada. Canadian production is of particular importance to us, as it offers a near source of supply in case of a possible temporary shortage of our own crop.

A careful study of the conditions in Canada reveals a possibility in increased production far ahead of any other present exporting country. Outside of Manitoba wheat production has only fairly begun, and yet the entire production can be made as large as that of the United States at present. The undeveloped resources of Alberta and Saskatchewan are very great. These two provinces and Manitoba are of chief present importance in grain production. The available farm area of the two larger provinces, based upon reports of provincial officials, is about 250,000,000 acres out of a total land area of 310,000,000 acres. This farm land would furnish a similar proportion for wheat as now employed in Minnesota and Kansas, or about one ninth of the area. This should be particularly capable of attainment because of the impossibility of any considerable corn production. One ninth of this farm area will furnish a wheat area of almost 28,000,000 acres. Manitoba employs now almost 3,000,000 acres. A conservative estimate, therefore, may be made, in round numbers, of 30,000,000 acres as the possible wheat acreage for these three provinces in 1950. The present average yield per acre of both spring and winter wheat for the three provinces, calculated from previous ten-year records, appears to be about 22 bushels, which should increase to at least 25 bushels. This rate of yield would allow a total annual production of 750,000,000 bushels, of which over 600,000,000 bushels would be an increase over present production. This possibility leaves out the increases that will occur in older provinces and the possible production in northeastern British Columbia and the Northwest Territory.

The possibility of wheat cultivation even in northern Alberta is not a matter of theory, but has been fully tested. In the year 1908, 35,000 bushels of wheat were already

grown in the vicinity of Ft. Vermillion at an average yield of 24 bushels per acre. Two stone mills and a modern roller mill are established at this point, which is 350 miles north of Edmonton. The wheat grown is probably not the best but appears to be of fair quality and has a fine appearance.

A similar line of reasoning to that in the above statements, which will not be given here in the desire for brevity, will lead one to the conclusion that European Russia may increase her production at least 600,000,000 bushels or to a total of 1,300,000,000 bushels. Argentina's wheat production has increased with unusual rapidity since 1904, reaching now an average of over 150,000,000 bushels. Three times that amount, or 450,000,000 bushels, is a low mark to set for that country's attainment by 1950. The most perfectly adapted area of the country for wheat lies in the southern part—old Patagonia—and is yet largely unexploited agriculturally. The wheats of best quality so far produced in Argentina come from the Chubut district in the northern part of this area.

The possible increases in foreign production just mentioned amount to about 1,500,000,000 bushels, which, added to the 900,000,000 bushels increase estimated for this country, gives a total of 2,400,000,000 bushels increase in production for the chief exporting countries. On the basis of previous relations of population to wheat production, and considering the increase in substitute foods that is sure to occur, the world will require, we may suppose, about 5,500,000,000 bushels of wheat by 1950, an increase of 2,000,000,000 bushels over present production. The above estimated total increase more than satisfies this requirement.

M. A. CARLETON
U. S. DEPARTMENT OF AGRICULTURE

MISS MATILDA H. SMITH

THE older members of the American Association will learn with regret of the death of Miss Matilda H. Smith, of Pittsburgh, Pa.

Miss Smith, with her sister, Miss Jennie M. Smith, has frequently been in attendance at the meetings in past years and has always taken a great interest in the advancement of science in a broad way.

Some years ago, they thought out a very original plan by which to aid the association in its general aims and at the same time to encourage certain scientific men of merit but of small income. This plan was to pay the life membership fee to the permanent secretary for certain men selected by themselves, often after consultation with Dr. Brashear.

A very considerable number of the life members of the Association owe their life memberships to this unobtrusive generosity on the part of the Misses Smith, and the permanent funds of the association, the income of which is devoted to the advancement of scientific research, has been considerably enlarged in this way.

Those of the members of the association who have been fortunate enough to enjoy the acquaintance of Miss Smith will miss her greatly.

L. O. H.

THE SUMMER MEETING OF SECTION E OF THE AMERICAN ASSOCIATION

THE following notice has been sent to all geologists and geographers, some 950 in number:

> For several reasons it has been decided to hold no summer meeting of Section E early in July. (1) These summer meetings have been attended so largely by educators in the eastern states that it seemed unwise to hold a summer meeting at the time of the meeting of the National Education Association, the week beginning July 4. (2) Mr. R. W. Brock, director of the Canadian Survey, has decided that it will be impossible to hold a meeting in Canada this summer as was suggested at the Boston meeting. (3) Many geologists will attend the National Geologic Congress in August and September.

The geologists and geographers were asked to express their opinion in regard to the wis-

dom of holding such a meeting late in August or early in September, to suggest localities in which the meeting might be held, and to state whether or not they might attend such a meeting.

Up to date nearly 300 replies have been received. Of these 100 think it wise to hold a summer meeting this year; 50 are doubtful; 105 think it unwise. No replies have been received from about 650. As about 50 have signified that they may attend a meeting if held early in September, it seems to the secretary that the probabilities are that a party of at least 25 would attend a meeting if held in one of the following localities: (1) Nantucket and Marthas Vineyard; (2) Chautauqua, N. Y.; (3) Shawangunk Mountains, Lake Mohonk and Delaware Water Gap; (4) seaside resorts near New York City, on Long Island Sound and the New Jersey coast.

The secretary would respectfully ask all who read this notice, and who would attend a meeting in any one of these four localities, to write him at once, stating their preference.

F. P. Gulliver,
Secretary Section E
30 Huntington Lane,
Norwich, Conn.

SCIENTIFIC NOTES AND NEWS

At the recent commencement season the University of Alabama conferred the doctorate of laws on Dr. William C. Gorgas, chief sanitary officer at Panama; Syracuse University conferred its doctorate of science on Dr. Lewis Boss, director of the Dudley Observatory, Albany, and the University of Wisconsin conferred the same degree on Dr. Franklin Hiram King, formerly professor of agricultural physics in the university.

Mr. Wilford M. Wilson, director of the Ithaca Weather Bureau, has been made honorary professor of meteorology by the faculty of the College of Agriculture, Cornell University.

Dr. Frank H. Bigelow has resigned his positions in Washington, D. C., as professor of meteorology, U. S. Weather Bureau (1891), professor of astrophysics, George Washington University (1894), and assistant minister of St. John's Church (1891), in order to travel in Europe for a few months. He will then resume his studies in solar physics and terrestrial meteorology.

Mr. Homer B. Latimer, of the University of Minnesota, has recently been appointed to a position as scientific assistant, U. S. Bureau of Fisheries, and assigned to the fish-cultural station of the bureau at Homer, Minn.

Dr. Walter L. Hahn, head of the department of biology in the State Normal School at Springfield, South Dakota, has been appointed naturalist in the Fur-seal Service, U. S. Bureau of Fisheries. The salary is $3,000. Dr. Hahn will sail from San Francisco early in August for Saint Paul Island, Bering Sea, where he will remain for two years. He will have immediate charge of all matters pertaining to the investigation, study and management of the fur-seal herd, the blue fox herd and all other animal and plant life on and about the Seal Islands.

Mr. James A. Lord, of the U. S. Census Office and formerly of the U. S. Immigration Commission, has been appointed statistician of the newly-organized Bureau of Railway Economics at Washington.

Dr. William N. Lynn has been appointed superintendent of the Lincoln Memorial Hospital at Knoxville, Tenn.

Professor T. W. Galloway, of James Millikin University, Decatur, Ill., has been elected secretary of the American Microscopical Society, and Professor T. L. Hankinson, of the State Normal, Charleston, Ill., treasurer, to fill vacancies caused by the resignation of the previous officials. At a recent meeting of the executive committee the plans of the new board for continuing the quarterly publication of the society were approved, contracts for printing and circulating the quarterly transactions authorized, and other routine business transacted.

A party from the department of botany of the University of Chicago consisting of Drs. Coulter, Chamberlain and Land and Mr. Brown, will engage in research work in Mex-

ico during September. Dr. Coulter will pay particular attention to the ferns of the Jalapa region, Dr. Chamberlain will continue his studies on Mexican cycads, chiefly in the mountains about Tierra Blanca and Tuxtepec, Dr. Land will collect liverworts in the Tuxtepec region, and Mr. Brown will study cacti.

PROFESSOR A. S. HITCHCOCK, systematic agrostologist, U. S. Department of Agriculture, is making a trip through Mexico in the interests of his work upon North American grasses. He is visiting, where possible, the type localities of the species of grasses based upon the work of the earlier botanists, such as Humboldt, Haenke, Schiede, Liebmann, Bourgeau and Schaffner, many of which species extend into our southwestern states.

DR. HARRY D. CHICHESTER, assistant fur-seal agent, who has spent the past eight months in Washington, is now in San Francisco purchasing supplies for the Seal Islands which will be sent to the islands on the last steamer which goes up in August. Dr. Chichester will return to Saint George Island on this steamer and remain until the fall of 1911.

PROFESSOR R. S. BREED, of Allegheny College, sailed for Antwerp on July 30, to attend the eighth International Zoological Congress in Graz, Austria. He will spend the principal part of the coming year studying in Germany, having been granted sabbatic leave of absence.

AMONG members of the faculty of the University of Michigan who are abroad the present summer are: Professor W. P. Lombard, physiology; Professor William H. Hobbs, geology; Professor G. L. Street, anatomy; Professor E. C. Case, zoology, and Professor Filibert Roth, forestry.

A TABLET in memory of Richard Hakluyt, the navigator, was unveiled in Bristol Cathedral on July 7, the address being made by Sir Clements Markham.

MR. J. B. CARRUTHERS, assistant director of agriculture of Trinidad, died on July 17. He was mycologist and assistant director of agriculture of Ceylon from 1900 to 1905. From 1905 to 1909 he was director of agriculture and government botanist to the Federated Malay States, and under his guidance the planting of Hevea rubber over extensive areas in the east was carried out. He assumed duties in Trinidad in September of last year.

THE *Experiment Station Record* states that an experiment station is being organized under the auspices of the Association of Sugar and Sugar Cane Producers of Porto Rico. This association was formed in San Juan, February 25, 1909, and is financed by a tax of twenty-five cents on each ton of sugar refined or two and a half cents for each ton of cane produced. One of its standing committees is the agricultural committee, which has for one of its duties the establishment of model farms, experiment stations and a technical sugar school. Mr. J. T. Crawley, formerly director of the Cuban station, has been selected as director of the experiment station, and will enter upon his duties in August. It is planned to secure in the near future a chemist, a plant pathologist, an entomologist and a field expert. A suitable location for the station is being sought. Mr. D. W. May, special agent in charge of the Porto Rico federal station, has been appointed an honorary member of the agricultural committee and is acting in an advisory capacity in the establishment of the station.

THE *Journal of the American Medical Association* states that the University of Pittsburgh will establish in connection with its medical department a laboratory and school for the study of backward children. The scope of the work will include psychologic studies of mental defectives and delinquents, both children and adults, epileptics and the nervous unfit of all kinds. It will also include work in the university laboratories and the training of nurses and prospective teachers in work of this kind. The work will be under the direction of Professor J. H. White, of the department of psychology, Dr. Edward E. Mayer, of the department of neurology, and Dr. E. Bosworth McCready will be the medical director. The school is to be called the Hospital School for Backward Children.

THE Harvard Summer School of Medicine offers a series of special lectures, open without charge to all members of the various Harvard summer schools, as well as to the medical pro-

fession. The remaining lectures will be given at 5 P.M. on the following dates:

August 5—"The Treatment of Fibrinous and Sero-fibrinous Pleurisy," F. T. Lord, M.D., instructor in clinical medicine.

August 9—"Some Common Affections of the Spinal Cord" (illustrated), E. W. Taylor, M.D., instructor in neurology.

August 12—"Examination of the Stools in Infancy," J. L. Morse, M.D., assistant professor of pediatrics.

August 16—"Intestinal Bacteria," A. I. Kendall, Ph.D., instructor in preventive medicine and hygiene.

August 19—"The Symptomatology and Treatment of Arteriosclerosis," W. H. Smith, M.D., instructor in clinical medicine.

August 23—"Dementia Præcox," E. E. Southard, M.D., Bullard professor of neuropathology.

August 26—"Surgical Diagnosis of Diseases of the Gall Bladder," F. B. Lund, M.D., lecturer on surgery.

According to the *Bulletin* of the American Mathematical Society, a meeting of the commissioners of the international commission of mathematical instruction will be held at Brussels during the week of August 9. While the meeting is of particular interest to Belgium and adjacent countries, some of the sessions will be public and of general interest. After the routine business, the chairman, Professor F. Klein, will deliver an address on the aims of the commission and give a report of the work already accomplished; Professor Bourlet will speak on the reciprocal relations between pure and applied mathematics in secondary instruction. A third report of the German sub-committee is in the press, and will be presented at the forthcoming meeting; it is by W. Lietzmann, on the organization of mathematical instruction in the boys' high schools of Prussia. Three reports from Austria and one from France are also in the press.

At the recent Boston meeting of the National Education Association the department of secondary education passed with only one dissenting vote the following resolutions:

Whereas, a wide range of high school subjects is now demanded in view of the varied needs of society, and the diversified interests of the different students; and

Whereas, manual training, commercial branches, music, home-making science and art, agriculture, etc., when well taught and thoroughly learned are justly entitled to recognition in college entrance credits; and

Whereas, colleges in certain parts of the United States continue to require two foreign languages of every applicant, regardless of his own interests; and

Whereas, this requirement in addition to such work in English, mathematics, history and science as is essential to the high school course of every student, precludes the possibility of giving adequate attention to these subjects; therefore, be it

Resolved, That it is the sense of this department that the interests of high school students would be advanced by the reduction of the requirement in foreign languages to one such language, and by the recognition as electives of all subjects well taught in the high schools; and be it further

Resolved, That it is the sense of this department that until such modifications are made by the colleges, the high schools are greatly hampered in their attempts to serve the best interests of the boys and girls in the public schools.

UNIVERSITY AND EDUCATIONAL NEWS

During the past few months Allegheny College, Meadville, Pa., has received the following gifts as part of a $500,000 endowment which is to be completed before April 24, 1912: $100,000 from the Rockefeller General Educational Board, $100,000 from Mrs. Sarah B. Cochran, of Dawson, Pa., and $25,000 from John F. Eberhart ('53), of Chicago, Ill.

The Yale Medical School has received $25,000 from an anonymous donor for the purpose of increasing the efficiency of the dispensary service.

Dr. Joseph A. Leighton, professor of philosophy and chaplain at Hobart College, has been elected to the chair of philosophy at the Ohio State University, vacant by the retirement from active service of Professor W. H. Scott. Dr. G. G. Richardson, of the University of Georgia, has been appointed professor of veterinary pathology, and Dr. O. V. Brumley has been promoted from associate professor of veterinary medicine. Mr. Frank J. Ryder, of the Forest Service, has been appointed instructor in forestry.

AT the University of Illinois assistant professors have been appointed as follows: Dr. John Byrnie Shaw, mathematics; Dr. George F. Arps, of Indiana University, psychology; Mr. David Varon, of New York City, architectural design, and William Thomas Bawden, of the State Normal School, Normal, Ill., engineering.

RECENT appointments in the School of Mines of the University of Pittsburgh are as follows: Horatio C. Ray, B.S., instructor in metallurgy; Harry N. Eaton, A.M., instructor in geology and petrography; Henry Leighton, A.B., instructor in mining geology and mineralogy; Harry B. Meller, E.M., instructor in mining.

THE Toronto correspondent of the New York *Evening Post* states that appointments at the university have been made as follows: Dr. J. A. Arnyot, director of the laboratory of the provincial board of health, to be professor of hygiene, in succession to Dr. William O. Wright, resigned; H. E. T. Haultain, professor of the new chair of mining engineering; Dr. W. H. Piersol, associate professor of histology and embryology; Dr. K. C. McIlwraith, associate professor of obstetrics; S. R. Creaser, lecturer in surveying; W. W. Frey and J. J. Traill, lecturers in mechanical engineering; J. H. White, lecturer in forestry and botany; Alex. McLean, lecturer in geology.

DR. HOWARD L. BRONSON, assistant professor of physics in McGill University, has been appointed to the chair of physics in Dalhousie University, Halifax, vacated by the resignation of Professor A. S. McKenzie to accept a chair in the Stevens Institute of Technology.

DISCUSSION AND CORRESPONDENCE

THE BEARING OF PSYCHROMETER READINGS ON MEASUREMENTS OF MARTIAN AQUEOUS VAPOR

TO THE EDITOR OF SCIENCE: Referring to Dr. Abbot's letter to Director Percival Lowell,[1] the point at issue can not be settled by psychrometer readings, taken merely at the earth's surface.

Dr. Slipher, in commenting upon the Flagstaff Mars-moon spectrogram Rm 3050, taken at the Lowell Observatory, January 15, 1908, when the psychrometer indicated 1.30 grains of water-vapor per cubic foot of air, and comparing it with plate Rm 3062, taken on January 21, with a vapor-reading of 1.02 grains, says:

> A long series of exposures to the spectrum of the moon at different altitudes, made on the same night [January 15] . . . verify the lunar images of the Mars spectrogram in showing that the moisture in our air was relatively very much less than for plate Rm 3062, notwithstanding the meteorological records to the contrary. The strength of the *a* band depends upon the actual amount of aqueous vapor in the light path and is, therefore, a very reliable measure, whereas the meteorological observations can not be reliable for they depend upon the moisture in a small sample of air at the earth's surface which may be very different from what it is a short distance above.[2]

Director Campbell says:

> It would be interesting to know how much vapor was traversed by the rays of Mars and the moon when the spectra were recording themselves on the sensitive plates, but to speculate on the subject, from the thermometer readings, seems useless, in view of the unknown law of distribution of vapor in the strata above the thermometers. The vapor bands in the spectrograms themselves furnish the only known rational method of estimating the quantity of vapor traversed.[3]

The same principle is recognized in my "Reply to Campbell's criticism," where I say:

> It is the distribution of moisture through the entire air column that we should like to know, and this is hardly affected by such surface changes as occur in an arid region. . . . Any great accuracy in the determination of surface humidity would be labor wasted for the present purpose. A mean diurnal, or possibly a mean monthly, humidity may be quite accurate enough.[4]

[1] SCIENCE, June 24, 1910, p. 987.

[2] V. M. Slipher, "The Spectrum of Mars," *Astrophysical Journal*, Vol. 27, No. 5, p. 401, December, 1908.

[3] W. W. Campbell, "The Spectrum of Mars as Observed by the Crocker Expedition to Mt. Whitney," *Lick Observatory Bulletin*, No. 169, p. 153, October 1, 1909.

[4] Frank W. Very, "Water Vapor on Mars—Reply to Campbell's Criticism," *Lowell Observatory Bulletin*, No. 43, p. 240.

Thus the three investigators of the *a* group in the Martian spectrum, Slipher, Campbell and Very, are in complete agreement as to the failure of the psychrometer readings to give reliable information about the humidity of the total air column, which is the important datum of this test. If any further demonstration of this point is needed, it may be found in Campbell's spectrogram No. 3, September 2, 1909, where the mean light paths were 5.15 for Mars, 3.61 for the moon, and the moisture by sling psychrometer was about 2.9 grams per cubic meter at the time of the Mars spectrogram, but only about 0.3 grams ±, when the lunar images were being recorded. Yet notwithstanding the presence of a quantity of terrestrial aqueous vapor about fourteen times as great for the Mars spectrogram as at the time of the lunar impression, if we are to trust the meteorological records as Dr. Abbot wishes, Professor Campbell merely notes that little *a* "seems to be a shade stronger in *Mars* than in the moon." Evidently, either the psychrometer readings are not to be relied on, or the photographic process must have been very insensitive. Perhaps a doubt may be permitted on both of these scores.

Dr. Abbot holds that, while the weather may have been bad during a large part of his stay on Mt. Whitney, the conditions as to humidity were favorable on the nights when Director Campbell made his observations, and that the spectrograms are "entirely conclusive," while there is "no evidence at all of water-vapor on Mars." *Per contra,* the fact is that in spite of the low relative humidity on the summit of the mountain on the nights of September 1 and 2, we have no knowledge of the conditions in the air column through which the rays passed, except as these may be surmised from the general seasonal and regional meteorological data. The top of a high mountain is the seat, during the day time, of an abnormal local ascensional movement of air, heated by contact with the insolated slopes of the mountain. At night the convection is reversed. Air from an elevation above the summit descends, and with relative humidity reduced by virtue of compression in the downward movement, a nocturnal abnormal condition of local dryness is liable to be produced. In the free air, far from the mountain top, quite other conditions may prevail.

The upper air is affected by the great general and seasonal movements of the atmosphere. In summer, a mantle of aqueous vapor distributed through a wide range of altitude prevents excessive radiation to the celestial spaces. The night temperature at the summit of the mountain in September descended to a little below the freezing point, but this does not indicate the complete removal of summer conditions in the upper air over the whole surrounding country. The depression of humidity may have been, and probably was, largely local, and in any case, considering the altitude (14,500 feet), the cold was not exceptionally severe, and does not point to any extensive withdrawal of a protective envelope of vapor from the surrounding region, such as occurs in winter. On the contrary, since the weather over the whole southwest had been for some time excessively rainy, the entire air column over the region, taken as a whole, was probably unusually replete with moisture. The great mass of air through which an inclined and long line of sight passed, as in Campbell's spectrogram No. 3, where the altitudes were 11°.2 and 16°.1, was comparatively unaffected by the local air movements of the mountain top. The spectrograms prove nothing definitely. Interpreting them as Dr. Abbot would have us do by the psychrometer readings, they are barely able to detect a variation of moisture in the ratio of fourteen to one in the case noted above. By Campbell's own account they are poor specimens, being weak in the neighborhood of *a*, and having other photographic defects. It is in the photographic process that the real crux of the problem lies. I can best illustrate this by an example.

Being engaged in a revision of Rowland's intensities of the solar Fraunhofer lines, I have had occasion to note the exceptional uncertainty of those estimates which lie on the

verge of the barely visible. For instance, examining a particular line to which Rowland assigns the intensity and character denoted in his notation by the symbols 0000 N d ? (meaning one of the faintest lines, hazy and suspected of duplicity) on the excellent photograph by Higgs, I find this line to be invisible throughout a large part of its extent; but at a particular spot on the spectrogram the line comes out clearly double, then disappears, and is only seen again as a faint nebulous spot at another point in the line. Here the variations of sensitiveness at different points on the same photographic plate are responsible for changes from the clear definition of a close double, to invisibility. How absurd would be the proposition that this particular line must be dropped from the list of acquired data of solar spectroscopy, because it may fail to appear on a given plate! A fact of science which is difficult to determine, being once acquired, is not overturned because of failure to reproduce it. If the previous determination is satisfactory, the only assignable weight which can be given to the failure is zero.

It is quite possible that the renewed failure of Campbell and Albrecht to secure positive evidence of either water-vapor or oxygen in the Martian spectrum[6] is to be attributed to photographic difficulties; but the influence of the high dilution, that is to say, of the greater altitude and lower pressure of the Martian atmosphere, should not be overlooked.

We know from the behavior of different emission lines in the spectrum of the same element under varying conditions of temperature, pressure or mode of electrical excitation, that individual lines, even when very strong, may disappear at the same time that weaker lines are reenforced. These and other variations are to be expected in the lines of absorption also. Before the significance of the absence of particular spectral lines can be determined, a critical study of the causes of their variation needs to be made; and if, in addition, the lines are very weak and barely capable of being photographed, the uncertainties of the photographic process must also be considered.

[6] SCIENCE, June 24, 1910, p. 990.

In *Lick Observatory Bulletin,* No. 169, Professor Campbell subscribes to the opinion, held by Vogel and Keeler, "that high resolving power was not necessary, or even desirable, in visual observations of spectra no brighter than those of Mars and the moon." This of course does not necessarily apply to photographic spectra; but we may inquire whether, owing to a broadening and weakening of individual absorption lines when a given mass of absorbent is distributed through a large volume of diluent, the effect of a group of broad and faint lines, combined into one indistinguishable band in an instrument of low power, may not be more easily recognized than individual lines photographed with high dispersion; and whether possibly the peculiar conditions of the Martian atmosphere may not favor such a constitution of the Martian, as distinguished from the terrestrial bands?

FRANK W. VERY
WESTWOOD ASTROPHYSICAL OBSERVATORY,
WESTWOOD, MASS.,
June 28, 1910

Addendum: The method of distinguishing Martian and telluric absorption lines by the velocity-shift of the Martian lines at quadrature is not new. It was not only explained and advocated by Dr. Percival Lowell, but was actually tested at the Lowell Observatory by Dr. Slipher in 1905, with the same negative result that Professor Campbell and Dr. Albrecht now obtain in repeating the experiment. A full account of the method and its results was published at the time in *Lowell Observatory Bulletin,* No. 17. That the method is not a delicate one is shown by its failure hitherto, when applied to Venus which possesses an undoubted atmosphere.

F. W. V.

QUOTATIONS

MEDICAL APPOINTMENTS AT VIENNA

THE half-hearted way in which the requests of Professor Strümpell for a modern outfit for his clinic were met by the authorities has had an unexpected result. The professor has "given notice" he will leave his post at once

to accept the appointment of clinical professor in Leipsic, as successor of Curschmann. To understand the sensational effect of this decision, one must understand that Strümpell had been won for Vienna only with great difficulty, and that promises had been made to him, which if fulfilled, would have enabled him to develop the third Vienna medical clinic according to his ideas. When he took over this present office a year and a half ago, as successor of Schrötter, he was received with the greatest pleasure by the students, who wanted to obtain a first-class teacher. Numerous bureaucrats and professors who thought it unnecessary to call another man from Germany were less pleased with his appointment. And von Strümpell always found that he was regarded as an outsider by many men. Among the students, however, he was much beloved and respected, and his patients always praised his kind and benevolent manners. Strümpell's idea was to make Vienna a Mecca of first-class clinical teaching. Instead of being assisted in every possible way by the authorities, he has been hampered all along. Naturally, he lost all pleasure and seized the first opportunity to leave a place where his abilities were not regarded as sufficient to warrant a little disregard of routine and red tape in monetary questions. His loss is another sign that science can not hope to progress if bureaucracy is prevalent.

The anatomic institute has been left without director by the death of Professor Zuckerkandl, but his successor will be soon appointed. Out of all the men able to fill the post, only three are actually eligible at present. They are Rabl, in Leipsic, Grosser, in Prague, and Tandler, in Vienna. It is the custom in this country, whenever a new medical teaching appointment has to be made, for the senate of the university to call the attention of the ministry of education to at least three men, named in order of preference. Very seldom is one man recommended as the first and only candidate. This has been the case just now, when Professor Tandler has been presented by the senate. He has been for the last four years *locum tenens* for Zuckerkandl, who was obliged by illness to abstain from all but very slight work. Tandler has gained the esteem and the attention of students and scientists alike during the time he has been active in the anatomic department. It is not impossible, however, that some outsider will be appointed, for it has happened sometimes that influences more powerful than scientific requirements have been able to outweigh the recommendation by the senate.—*Journal of the American Medical Association.*

SCIENTIFIC BOOKS

The Mammals of Colorado: an account of the several species found within the boundaries of the State, together with a record of their habits and of their distribution. By Edward Royal Warren, S.B., Director of the Museum of Colorado College. With three maps and a full series of illustrations reproduced from photographs taken from nature. New York and London, G. P. Putnam's Sons. The Knickerbocker Press. 1910. 12mo, pp. xxxiv + 300, 3 maps and 84 text-cuts. $3.50.

In the matter of local manuals of the mammals of North America, the supply is far behind that available for birds. Of the half-dozen that have thus far appeared, the latest, Mr. Warren's "The Mammals of Colorado," is easily one of the best. It is thoroughly scientific in spirit, and yet not too technical for a popular hand-book. The large number of text illustrations comprise one or more views of a skull of some representative species of nearly every genus, with many others from life, showing the characteristic external features of the species, while others illustrate the nests of various rodents, and the work of the beaver. The maps include a contour map of the state, and maps showing the distribution of the prairie dogs and of three species of striped squirrels. The introduction contains instructions for skinning and measuring mammals for scientific purposes, a chapter on the life zones of Colorado, and ten pages of bibliography. The book appears to have been first projected by Mr. William Lutley Sclater, the author's predecessor as director of the Museum of Colorado College, who, on being

forced to abandon the undertaking by pressure of other work, turned over his manuscript to Mr. Warren, who not only makes due acknowledgment for important aid in preparing the diagnoses and keys of the higher groups, and for other assistance, but dedicates the work to his helpful friend. The species and subspecies are briefly but clearly described, and their distribution is given in detail so far as it is known, following which, and printed in larger type, is a more or less extended biography. In the case of the rodents and other small mammals, the biographical matter is generally given under the leading member of the group (genus or species, as the case may be), since among closely allied forms there is no essential difference in habits.

The number of species and subspecies here recorded for Colorado is about 150. In the matter of nomenclature the authorities of the biological survey have evidently been followed.

In style of treatment and character of matter "The Mammals of Colorado" sets a good standard for similar works, and its usefulness will be appreciated far beyond the region with which it deals. It satisfactorily reflects present knowledge of the mammal fauna of Colorado, and forms a good basis for the addition of details at present unknown. Furthermore, it contains a vast amount of original information here published for the first time.

J. A. ALLEN

Researches on Fungi. By A. H. REGINALD BULLER. London, Longmans, Green and Co. 1909. 5 plates and 83 figures. Pp. xi + 287.

In this work the author gives the results of his intensive researches on the problems of the dispersal of spores of the Hymenomycetes and other related topics. The book is most satisfying. It gives a mass of new facts well arranged and carefully summarized, by chapter and as a whole, together with full descriptions accompanied by clear figures which show the accuracy of the method and its painstaking character. The experiments are ingenious and brought as far as possible to a conclusion.

Buller points out the admirable features of the sporophores of the agarics, such as the great increase in hymenial surface through the gills, the immense number of spores thus accommodated, together with the economy in the introduction of the shorter gills. The adhesive spores are spaced by the paraphyses and each one has unobstructed access to the open air. The stipe is advantageously placed, commonly central, is often a hollow tube following the well-known engineering structure. It is rigid through longitudinal tensions, holding a cap generally set at a position of stable equilibrium. The annulus serves as a foil in preventing insects from climbing to the unripe gills, yet does not interfere with the spore currents.

In certain chapters which might be said to have a philosophical trend, the phyletic value of the color of spores is considered; anemophily is compared with coprophily and the general problem of the arrangement of the group is touched upon. In this last the author opposes the views of Massee, who holds the Coprini to be primitive.

To the increasing amount of work that is being done on the tropic and morphogenic responses of the mushrooms, the researches of Buller make a distinct addition. His work on *Lentinus lepideus* has been previously published[1] but he reviews the main conclusions. He continues his experiments with the mushroom, with coprins and some polyporoids. The mushroom shows no light reaction, geotropism alone being effective. With *Polyporus squamosus* light is morphogenic but not directive, since the pilei do not develop without light, but their growth is not directed toward it. Gravity plays a part in the final adjustments. With coprins interesting pendulum-like physiological swingings—a parallel to the responses of phanerogam shoots—were obtained by tilting. In the coprins, generally, heliotropic responses were found; this seems to be a necessary consequence of the peculiarly irregular substratum, enabling the sporophores to avoid obstacles. This coupled with the rhythm in development insures the

[1] *Annals of Botany*, 1905, XIX., 427–438.

stretching of the stipe at times when light can be used as a directive influence.

One of the most interesting discoveries recorded in the book is that with reference to the ejection of the spores from the sterigmata. It is found that the spores may be expelled ten to thirteen times their own length and that they fall from the gills in a peculiar curve that Buller calls "sporabola." The emission of a powder from polyporoids had been seen before, but as a very rare occurrence. It has remained for Buller to devise by means of a beam of light a method of determining readily whether spores are being discharged or not. Then by observing some mature spores on a section of a gill, he was able to determine that the spores were actually projected, although the actual flight through the air could not be seen. This ejection is independent of hygroscopic conditions, takes place but slowly at 0°, and is stopped by anesthetics and by lack of oxygen. It is therefore a phenomenon of protoplasmic activity, not a mere result of hygroscopic tension.

For the Basidiomycetes the hypothesis is advanced that the discharge of spores is similar to the jerking process described for *Empusa* by Nowakowski. It involves the mutual bulging of the walls of the sporidia and the sterigmata, in opposite directions.

On the side of physics, Buller pushes the matter to a fine point, determining the specific gravity of spores by floating them in different strengths of $CaCl_2$ (allowing for plasmolysis) and also determining the rate of fall in the air. The latter was an attempt to verify Stokes's law on the fall of microscopic bodies. The results show a velocity 50 per cent. greater than the computed rate.

In Part II., the spore dispersal of the Ascomycetes is considered. Here the observations of the author lead him to conclude that the explanation of deBary which attributes the expulsion of spores to mere loss of water does not explain the phenomenon of "puffing." In general Buller is led to believe that the "puffing" is caused by a stimulus given to the protoplasm in contact with the ascus lid.

Some of the interesting points in the book are: (1) The descriptions of the new Poynting's Plate Micrometer, (2) the figures on the increase of hymenial surface due to gills, (3) the number of spores per sporophore, (4) the specific gravity of various spores, (5) the effect of electric charges on different spores, (6) the persistence of vitality in certain xerophytic species, (7) the summary showing the present status of the work on the nuclear phenomena in the Basidiomycetes and (8) the problems suggested with reference to the relation of insects and spores.

G. H. Coons
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Nebraska Experiment Station

Experimentelle Untersuchungen über Atomgewichte. Von Th. W. Richards und seinen Mitarbeitern 1887–1908. Deutsche Ausgabe von J. Koppel. Pp. viii + 890. Hamburg und Leipzig, L. Voss. 1909. Preis M. 35.

Theodore William Richards occupies in our time, with regard to the precise determination of atomic weights, the place which was occupied in the first half of the past century by Berzelius and in the second half by Stas. And just as Stas, in his memorable investigation of the atomic weight of carbon, carried out jointly with Dumas, demonstrated the necessity of a new and independent study of the entire problem by his discovery of a not inconsiderable error in the atomic weight found by Berzelius, so Richards proved the necessity of his own researches by demonstrating the inexactness of Stas's fundamental value for silver. However, there is also a deep-seated difference between the two achievements: the older discovery was made at the beginning of the new period, and was exploited by Dumas in his usual highly dramatic fashion; while Richards was almost forced, by a series of mutually corroborating deviations, to abandon the older value, at first regarded by him with complete confidence, and to accept his own unexpected result. This says: Dumas was a thinker of the romantic type, while Richards is a classic, just as Berzelius and Stas were classics. Indeed, atomic weights can be successfully determined only by a classic. Witness Dumas, who undertook it in

spite of his unsuited type of mind, found nothing but false values, although he devoted a long period of time to the determinations and used only the simple silver titration method.

Thus far the instinctive talent for avoiding methodical errors, which is clearly the characteristic of Richards's gift, has guided him so surely that no such errors have as yet appeared in his measurements extending over a period of over twenty years. Obeying his measuring instinct, Richards abandoned the method of working with large quantities, in which his celebrated predecessor Stas saw the greatest advantage, and returned to working with quantities of a few grams. The absolute errors of weighing, which led Stas to use large quantities, are so insignificant by the side of all other possible errors that the use of large quantities, with the complications of apparatus and preparative method arising from it, really introduces more errors than it eliminates.

A distinctive trait of the researches of this American investigator lies in his elegant simplicity of means. Just as Penny, in his time, carried out his masterly determinations with the simplest imaginable means, and yet attained a precision surpassing everything that his contemporaries had attained, so Richards shows us that refined complications of apparatus can mostly be dispensed with, if one only thinks a little longer over his problem before undertaking its experimental execution, and reduces the work to its simplest and most transparent form by first experimenting with the head.

As an instance of this I will mention only the simple device for closing a weighing tube *within* the apparatus in which the reaction takes place. This device has rendered possible the handling of many halogen compounds and other hygroscopic substances whose weight would be vitiated to an undeterminable extent by exposure to the air.

And so the study of these researches will be an excellent school for every nascent investigator whose heart's desire it is to learn to work precisely.

In conclusion, it is a satisfaction that this remarkable collection has been published in Germany and in the German language. With us, the publication of such a book is a pleasant enterprise for the publisher and involves no particular risk; in America no publisher could apparently be found who thought that there was "money in."[1]

WILHELM OSTWALD[2]

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VIII., No. 1, issued July 19, 1910, contains the following: "The Hæmocyanin of *Limulus Polyphemus,*" by C. L. Alsberg and E. D. Clark. The hæmocyanin from the blood of *Limulus* differs from that from the blood of *Octopus* in percentage composition and in various of its reactions. This fact shows that there are different hæmocyanins and that homologous proteins in different animals are not identical. "On the Preparation of Cystin," by Otto Folin. A convenient and rapid method for obtaining cystin in bulk. "Experiments Relating to the Mode of Decomposition of Tyrosine and of the Related Substances in the Animal Body," by H. D. Dakin. Experiments are described which do not support the view that homogentisic acid is a normal intermediary product in the catabolism of tyrosine and phenylalanine, and which show that this acid is not formed in the body from tyrosine by reactions similar to those which obtain in the oxidation of *o*- or *p*-hydroxybenzaldehyde by hydrogen peroxide. "The Fate of Inactive Tyrosine in the Animal Body together with Some Observations upon the Detection of Tyrosine and its Derivatives in the Urine. The Synthesis and Probable Mode of Formation of Blendermann's Para-hydroxybenzylhydantoïn," by H. D. Dakin. These experiments throw doubt upon the probability of the formation of either *p*-hydroxyphenyl-*a*-uramidopropionic acid or *p*-hydroxybenzylhydantoin in the metabolism of tyrosine. "On

[1] The translator leaves this as in the original.

[2] Translated by M. A. Rosanoff, from the German in the *Zeitschrift für physikalische Chemie,* Vol. 72, p. 759, 1910.

Alkylamines as Products of the Kjeldahl Digestion," by C. C. Erdmann. A method for the qualitative detection and approximate quantitative estimation of alkylamines in the presence of ammonia. Alkylamines were obtained from the product of the Kjeldahl digestion of methyl urea, creatin, creatinin and lecithin. "On the Alleged Occurrence of Trimethylamine in Urine," by C. C. Erdmann. Fresh, normal urine does not contain trimethylamine. "The Study of Autolysis by Physico-chemical Methods, II.," by Robert L. Benson and H. Gideon Wells. A discussion, with experimental data, of the value of estimations of freezing point and electrical conductivity in the study of autolysis. "A Method for Treating and Preserving Large Quantities of Urine for Inorganic Analysis," by Edgar F. Slagle. Add sulphuric acid and evaporate to dryness. "Phosphorus in Beef Animals, Part II.," by C. K. Francis and P. F. Trowbridge. Analytical data showing percentages of water, fat and phosphorus in various parts of cattle. "Note on Chemical Tests for Blood," by P. A. Kober, W. G. Lyle and J. T. Marshall. Tannic acid interferes with various common reactions for blood, hence water, not tea, should be given in test meals when the presence of blood is suspected.

A NEW PRINCIPLE IN THE MECHANISM OF NUCLEAR DIVISION

The present conception of the causes, which determine the movements of the chromosomes and achromatic constituents of the nuclei of vegetable cells, can hardly be said to be in accordance with our views concerning the mechanical causes of other movements of plants.

It assumes contractility of protoplasmatic parts and affinity between homologous organs as the chief forces in play, but this assumption is evidently not sufficiently supported by what we know about contractility and organic affinity in other domains of physiology.

In a recently published paper, prepared in the laboratory of Strassburger, in Bonn, Mr. Theo. J. Stomps proposes a new principle for the explanation of the mechanism in question.[1] It is based on our knowledge of the function of osmotic forces in the growth of cells and in the movements of plant-organs and simply assumes the same forces for the process of nuclear division.

About forty years ago Sachs discovered the now universally acknowledged fact that growth and related movements, such as geotropism and heliotropism, are determined by the distending of the cell walls through the osmotic activity of the cell sap. The tension of tissues in growing parts was found to be due to the same cause, as were the reactions of sensible stamens to the stings of insects and of the motile organs of leaves to the changes in the intensity of the light.

At that time the presence of vacuoles with cell sap in very young cells, during their meristematic condition, was still unknown. This important fact was since discovered by Went, who proved the individuality and continuity of these vacuoles in the same way as this had been done for chloroplasts by Schmitz and Schimper. The foamy condition, which is now found to be so general in the protoplasm surrounding nuclei during their division, is due to the presence of numerous small vacuoles filled with cell sap. The walls of these vacuoles are to be considered as living parts of the protoplasm and as active in the secretion and accumulation of those substances which determine the osmotic pressure of the cells. These vacuoles may divide themselves or unite in groups into larger ones in the same way as these changes have so frequently been observed in older cells.

Starting from observations on the behavior of the chromosomes during the nuclear divisions in *Spinacia oleracea* and other plants, and especially from their visible changes during the synapsis and the reduction-divisions which prepare the production of the sexual cells, Mr. Stomps proposes a new principle for the mechanical explanation of these phenomena in general.

[1] Theo. J. Stomps, "Kerndeeling en Synapsis by *Spinacia oleracea* L.," Amsterdam, 1910.

He assumes that here also vacuoles are at work, and by their extension and subsequent collapsing produce all the movements which constitute the whole process of nuclear division, including the transportation of the chromosomes from the equatorial plane to the poles of the spindle and their subsequent assuming of the reticular condition in the resting nuclei.

In describing his observations as shortly as possible, we may start from the transportation just named. Fischer assumes movements of the granular plasm to account for this phenomenon, whilst most cytologists invoke a contraction of the threads of the spindle. But in *Spinacia* a longitudinal row of vacuoles is seen between the two separating halves of the chromosomes. Moreover, the spindle becomes larger during this process, and not smaller, as it should on the ground of the latter supposition. Often the chromosomes separate first at their free ends, instead of diverging first at the points where they are united to the threads of the spindle. This indicates the swelling of the vacuoles between them as the mechanical cause of their separation.

After reaching the poles of the spindle, the chromosomes at first constitute a compact group, but this is soon distended. Vacuoles are swelling between them; their walls are seen in the shape of fine lines of linin, giving the image of threads stretching from one chromosome to another. The swelling of these vacuoles is then seen to continue, they increase in volume, come forth from amidst the chromosomes and finally surround them on all sides, until their walls touch one another. In this way a complex group is produced, the outer walls of which combine to constitute the nuclear membrane, whilst the inner parts of the walls either disappear or otherwise become invisible.

The chromosomes now change from the compact into the reticular condition. They do so by means of numerous very small vacuoles, which slowly increase in size, and thereby distend the surrounding material. Each of the chromosomes is changed in this way into a network and the whole nucleus becomes a *"réseau de réseaux"* as it has been called by Grégoire.

When at the close of the reticular or resting period the nuclei return to activity, all these processes are, of course, gone through in the opposite direction. First the chromosome-vacuoles collapse, thereby restoring the compact condition. Then a longitudinal row of vacuoles appears in each chromosome, indicating the beginning of their division. Afterwards the nuclear vacuoles collapse, causing the nuclear membrane to disappear.

Even as in the petals of some colored flowers colored and uncolored vacuoles may be seen within the same cells, betraying different physiological properties of the individual vacuoles, Mr. Stomps assumes different qualities for his three main groups of vacuoles, viz., chromosome-nuclear and spindle-vacuoles.

The point in his description which will probably interest his readers most of all is the explanation of the nuclear membrane as a wall of numerous vacuoles, or a compound tonoplast.

In comparing the drawings and descriptions of Strasburger and others and especially those of Grégoire, with this new principle, it will easily be seen that in the main they quite well agree with it. The description of the nuclear division in the roots of *Allium* by Grégoire[2] may even be considered as good corroborative evidence. On the other hand, it is always hazardous to base a physiological hypothesis on the observation of fixed and stained material only. Experiments on the behavior of the new nuclear vacuoles during active life seem strongly required for a fully reliable proof.

HUGO DE VRIES

SPECIAL ARTICLES

UNISEXUAL BROODS OF DROSOPHILA

IN an experiment begun at Columbia University in March, 1909, several pairs of pomace flies produced broods consisting of males only, or females only. The sexes of *Drosophila* usually appear in very nearly equal numbers. Table I., A and B, gives the figures

[2] *La Cellule*, T. XXIII., Fasc. 2, 1906.

for the first set of broods, from parents one or both of which were submitted to very high temperatures at some period during the larval stage, or during the early adult stage before mating. A similar result was, however, obtained from a control series, as shown in Table II., indicating that the high temperature used was not the cause of the unisexual broods.

TABLE I. (51 PAIRS)

A. *Unisexual Broods (from 9 Pairs)*

	Male	Female
1	135	0
2	0	108
3	0	104
4	0	73
5	0	63
6	0	45
7	0	43
8	0	33
9	0	31
Total	135	500

B. *Bisexual Broods (from 42 Pairs)*

	Male		Female		Both Sexes
Largest brood	99	+	95	=	194
Smallest brood	12	+	11	=	23
Total number of flies	1994	+	1992	=	3986
Average brood	47.47	+	47.42	=	94.9

Deviations from normal sex-ratio of 50 per cent.:

Maximum ..... 15.00 % (♂ 35.00 % + ♀ 65.00 %)
Minimum ..... 0.00 % (equality)
Average ..... 4.53 %

TABLE II. (21 PAIRS)

A. *Unisexual Broods (from 3 Pairs)*

	Male	Female
1	0	68
2	1	52
3	0	30
Total	1	150

B. *Bisexual Broods (from 18 Pairs)*

	Male		Female		Both Sexes
Largest brood	181	+	177	=	358
Smallest brood	36	+	23	=	59
Total number of flies	1428	+	1383	=	2811
Average brood	79.33	+	76.83	=	156.1

Deviations from normal sex-ratio of 50 per cent.:

Maximum ..... 11.01 % (♂ 61.01 % + ♀ 38.99 %)
Minimum ..... 0.35 % (♂ 50.35 % + ♀ 49.65 %)
Average ..... 3.11 %

The total number of flies making up the bisexual broods consists of males and females in almost equal proportions. The sexes of these individual broods also ran fairly even except in a single case (Table II., A, No. 2) where the sex ratio is 52:1, and which is placed with the unisexual broods on this account, as well as for another reason which will appear below.

The flies were taken from a stock originally collected at Woods Hole by Professor T. H. Morgan, and bred in large numbers in several vessels. The offspring of these secondary stocks were isolated at various times in the pupal stage, and the virgin flies thus secured were paired in separate vials; the families of these pairs constitute the broods referred to in the present note. It is hardly possible that the parents of all the unisexual broods of Tables I. and II. can have sprung from a single pair of flies, and it therefore seems probable that the twelve pairs were separately acted upon by some unknown external factor which so strongly influenced the process of sex-determination that only one or the other sex was produced. This is, of course, not definitely proved, since no record was kept of sex-mortality, but it will be observed that the number of individuals in some of the unisexual broods is high enough, as compared with that of the bisexual broods, to suggest that the effect was not due to elimination of one sex but to substitution by the other.

In a second set of controls the 27 pairs all produced normal broods. The attempt to secure further results was then continued with the same stock at the Marine Biological Laboratory at Woods Hole through the summer of 1909, and again for more than half the season of 1909–10 at Columbia University, but without success, though over 700 pairs were bred and experimented with during that period.

The second fact connected with these unisexual broods became apparent after making many unsuccessful efforts to breed from them; the flies were all sterile, including the single male and all the females in the second "uni-

sexual" brood in Table II. Sections showed that the females have only very small, rudimentary ovaries, while no trace of a testis could be found in any of the males examined. Externally the flies appeared to be normal in every way, and the sterile males could be distinguished from females with a hand lens, by the coloration and other characters of the end of the abdomen, as in normal specimens. The preparations were made by serially sectioning the entire abdomen, in which process the hard copulatory organs, especially of the male, were always more or less torn and therefore can not be reconstructed; but from the fact that sterile males and females were observed to copulate with one another and with normal individuals it seems fairly certain that the copulatory apparatus of the sterile flies is normal. We thus have another example of development of the sexual instinct, and at least some of the external secondary sexual characters, independently of the gonads; and some additional evidence of independent differentiation of the copulatory structures.

Though the factor which caused the production of these unisexual, sterile broods was not discovered, there seems to be no reason why it should not turn up again; and it may be worth while for those engaged in breeding *Drosophila* to be on the lookout for a repetition of the occurrences above recorded, in view of their possible importance as bearing on sex-determination in general.

L. S. QUACKENBUSH

TWENTY-SECOND ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA

THE first session of the twenty-second annual meeting of the Geological Society of America, held at Boston and Cambridge, Mass., December 28–31, 1909, was called to order at 10 o'clock A.M., on Tuesday, December 28, in the lecture hall of the department of geology, University Museum, Cambridge, Mass., by Vice-president Adams, in the absence, on account of illness, of President Gilbert. In the course of the meeting the following program was offered:

The Post-Tertiary History of the Lakes of Asia Minor and Syria: ELLSWORTH HUNTINGTON, New Haven, Conn.

A study of the lakes of the Anatolian Plateau and of Syria was one of the chief objects of the Yale Expedition of 1909. The lakes fall naturally into five groups, namely, normal fresh-water lakes with ordinary outlets, salt lakes of the common type without outlets, karst lakes with underground outlets in limestone regions, glacial lakes with no definite outlets, but kept fresh by underground seepage, and crater lakes with similar indefinite outlets. In Syria the number of lakes is small, there are no glacial lakes and the other four types are sharply differentiated. The most interesting problems are, first, the part played by lava flows and deltaic deposits in the formation of Lakes Huleh and Galilee, and, second, the former outlet of the Dead Sea and the fluctuations to which this lake has been subject in Post-Tertiary times. In Anatolia the number of lakes is large and the various types merge into one another. For instance, crater lakes are sometimes saline, normal lakes have in some cases been drained by underground outlets, and salt lakes have in the past overflowed and been fresh. A comparison of the ancient strands and deposits of the lakes of both regions affords abundant data for the reconstruction of the varied climatic history of western Asia since the close of the Tertiary era.

Discussed by W. M. Davis, F. P. Gulliver, A. W. Grabau, D. W. Johnson and Joseph Barrell, with reply by the author.

Oscillations of Alaskan Glaciers: R. S. TARR and LAWRENCE MARTIN, Ithaca, N. Y., and Madison, Wis.

The National Geographic Society's Alaskan Expedition of 1909 observed the following glacial oscillations. In Yakutat Bay the Marvine lobe of Malaspina Glacier and the Atrevida, Haenke and Variegated glaciers have ceased the advance which began in the winter of 1905–6. The Hidden Glacier has advanced over two miles since 1906, but has now begun to shrink away from the new shore moraines. The Lucia Glacier is newly crevassed and advancing this summer, and is riding up on a nunatak. These oscillations confirm the earthquake-avalanche theory for glacial advance, proposed in 1906 by the senior author, and furnish facts as to the brevity of such advances. On the lower Copper River the Childs Glacier was more active in 1909 than 1908, but the position of the front remains unchanged. The Miles, Childs and Baird glaciers are essentially as in 1884, 1885, 1891 and 1900. In eastern Prince William Sound

the Valdez and Shoup glaciers are slowly receding. The Columbia Glacier has advanced rapidly since 1908 and is building moraines and destroying the forest, as was observed by Professor U. S. Grant early in 1909 and by the National Geographic Society expedition later in the season. The events in the glaciation of Prince William Sound differ decidedly from those in the Yakutat Bay region.

Discussed by François E. Matthes.

Some Effects of Glacier Action in Iceland: Fred E. Wright, Washington, D. C.

For the study of both glacial and volcanic phenomena Iceland is unique. Extensive remnants of its former ice cap still exist, while its land areas now free of ice are large and without forest cover and are admirably adapted for the physiographic study of the effects of glacier action, both of the continental ice sheet and also the valley glacier types. In a country covered by an ice cap, the surface of the ice sheet is an important plane of reference, which in its physiographic effect is often similar to that of a water surface, as sea level, toward which all exposed land surface tends to be reduced. Mountains and rock cliffs above the ice sheet undergo rapid changes in temperature, with accompanying shattering due to expansion of included moisture on freezing and tend to break down rapidly and to be reduced to the level of the ice surface. Beneath the ice cap, on the other hand, ice erosion tends to accentuate the differences in elevation by cutting deeper into the existing valleys, especially if these lie in the direction of the main ice flow, while the mountain tops, nearer the surface of the ice sheet and consequently under less pressure and of gentler gradient, are eroded less than other areas. The net result of such action, if continued long enough, would be to reduce the mountain peaks to about the same general elevation, so that taken together they would eventually resemble an old uplifted and dissected base level of erosion.

Discussed by W. M. Davis.

The Cliff Sculpture of the Yosemite Valley: F. E. Matthes, Washington, D. C. (Introduced by M. R. Campbell.)

The Yosemite Valley may be epitomized as a glacial canyon laid in structurally aberrant materials. It is to the latter circumstance chiefly that the valley owes its remarkable wealth of sculptured forms. These are not inherently a product of either stream or ice erosion—they are a function of the structure of the country rock. The granites of the Yosemite region may be pictured as consisting of many huge monolithic masses imbedded in a matrix of more or less strongly fissured rock. This unusual structural habit naturally carries with it extreme inequality of resistance to disintegration. As a consequence, rock structure has played a prominent rôle in the evolution of the topography of the region. The Yosemite landscape indeed reflects in its features the structural character of the materials from which it has been carved: its dominating heights consist invariably of intractable monoliths, its canyons and gulches are due to zones of easily eroded fissile rock. The glacial cross cliffs and lake basins in the valley floors, the headlands and embayments of the rock walls, have in each case evolved in obedience to local structural controls. The very trend and profile of each cliff has been determined by structural planes. Indeed, every rock form and monument of the valley is to be interpreted as an expression of its associated structures. This applies also to those notches and niches about the waterfalls which have heretofore been explained as the result of the shifting of the falls in glacial times.

Further Light on the Gorge of the Hudson: James F. Kemp, New York, N. Y.

The paper gave the latest evidence furnished by the deep borings in the Hudson Valley at the Storm King crossing of the New York City aqueduct, and cited the results of the Pennsylvania Railroad tunnels opposite Thirty-third Street, New York, made public through Dr. E. O. Hovey. The facts were interpreted and involved the general problem of glacial over-deepening. The paper practically continues one by the writer in the *American Journal of Science* for October, 1908, p. 301.

Discussed by J. W. Spencer with reply by the author.

The Richmond Bowlder Trains: F. B. Taylor, Fort Wayne, Ind.

The paper described the well-known trains of bowlders of amphibolite schist which extend southeastward into southwestern Massachusetts from "The Knob," formerly called Frye's Hill, which is on the line between the towns of New Lebanon and Canaan in the northeastern part of Columbia County, N. Y. The hill is about nine miles west of Pittsfield, Mass. The train which has been described heretofore and which was visited by Sir Charles Lyell many years ago is composed of large angular blocks strewn along a line running southeast from Frye's Hill. It takes a nearly straight course over mountain and valley with but little curvature or interruption for about

seven miles and is faintly traceable for about twice this distance. Another train, not previously described, but composed of bowlders of the same rock and probably derived from the same source, extends about sixteen miles directly south from Frye's Hill. This train is not so well defined, it is more diffuse and has not yet been traced through the whole distance. Although apparently the same rock, these bowlders are all well rounded and show more weathering than the angular blocks. The relations and apparent significance of these separate trains were briefly discussed.

Shorelines of the Glacial Lakes in the Oberlin Quadrangle, Ohio: FRANK CARNEY, Granville, Ohio.

The paper described the varying features shown in the shorelines of the Maumee, Whittlesey and Warren lake stages, and discussed the factors involved.

Isobases of the Algonquin and Iroquois Beaches and Their Significance: JAMES WALTER GOLDTHWAIT, Hanover, N. H. (Introduced by F. B. Taylor.)

During the past five years, instrumental measurements of altitude of the raised beaches of Lake Algonquin in Illinois, Michigan, Wisconsin and the province of Ontario, have provided new data for the construction of isobases of elevation of the Algonquin beach in an area 450 miles east and west by 300 miles north and south. These measurements not only fix the identity of the Algonquin beach throughout that region, but disclose the exact direction and rate of post-Algonquin tilting at all places within it. It is possible, moreover, to fix the position of an "isobase for zero," or "hinge line," northeast of which there has been differential uplift, but southwest of which no uplift since the making of the Algonquin beach. This horizontal portion of the water-plane is believed to indicate the original height of Lake Algonquin and serves as a datum plane from which to compute the amount of uplift of more northerly localities. On the basis of measurements by Spencer, Gilbert, Coleman and Fairchild on the Iroquois beach, isobases are drawn for that plane over Lake Ontario. The Iroquois and Algonquin planes are then compared. These conclusions are reached: (*a*) that these two stages of the neighboring lakes were nearly contemporaneous, but that the Iroquois is probably somewhat older; (*b*) that the differential uplifts in which the Algonquin-Iroquois region participated, although of well-nigh continental extent, were here (as in the case of Lake Agassiz) of wonderful regularity, and (*c*) that whether due to isostacy or not, the uplifts centered in the Laurentian oldland, and the isobases bear a significant relation to its border, as DeGeer pointed out nineteen years ago.

The paper was discussed by J. W. Spencer, Frank Carney and F. B. Taylor, with reply by the author.

The Diversion of the Montreal River: ROBERT BELL, Ottawa, Canada.

This paper described a remarkable example of change in the destination of a large river in which the stream has been diverted in post-glacial times into a new channel that carries its waters all the way to its present mouth in a straight course of 90 miles, which lacks only 45° of being exactly opposite to that of the upper part of the stream, as well as its former continuation below the point at which the change took place; that is to say, that at a certain point the course of the river was turned round through an angle of not less than 135°, or from a north to a southeast direction, and made finally to discharge into the Atlantic Ocean instead of Hudson Bay. This singular occurrence was rendered possible from the fact that in one part of its course the river was barely able to pass across what has now become a low divide, and that a slow rising or tilting of the land to the southward gradually stopped the northward flow of the river, while at the same time the changing conditions induced a process of "stream-robbing" through a dam of loose drift material a short distance east of this increasing obstruction. The paper described numerous facts, which, taken together, seem to prove the manner in which this important and interesting phenomenon was accomplished.

On the Relative Work of the Two Falls of Niagara: J. W. SPENCER, Washington, D. C.

This paper should be considered as an additional chapter to "The Evolution of the Falls of Niagara," by the writer, wherein the work of the smaller cataract and the relative efficiency were scarcely considered. The American Falls carry only five per cent. of the total discharge, and are now some 50 feet lower than formerly, with the recession, as affected by the talus, undeterminable by measurement, but calculated at 0.27 foot a year, as probable. The removal of the fallen masses of limestone beneath the main cataract, below a depth of 72 feet, appears to be largely by solution. By soundings, experiment and calculation it is found that approximately a third of the periodic law, on an increasing helix, on a half

mechanical effect is lost in the cushion of water below the falls, which thereby balances any lesser efficiency of the smaller falls, which strike directly on the talus below. In the variable energy, the power of deepening the pool beneath a waterfall seems to act as a mean balancing medium, so that there is found no reason for deviating from the laws of erosion in the changes at Niagara, until some unexpected discovery shall be made. So far, the author has been unable to find any grounds, based upon observation, for greater variation in the approximate age of Niagara than those provided for.

Natural Bridges of North America with a Discussion of Their Origin: HERDMAN F. CLELAND, Williamstown, Mass.

A. Natural bridges initiated by stream erosion.
   1. By the perforation of the neck of an incised meander.
   2. By pot-hole action.
   3. By erosion assisted by frost action. (Yellowstone.)
   4. Travertine-cemented stream deposits undercut by stream action.
   5. By the undercutting of a petrified log.
   6. By the headward cutting of two streams.

B. Bridges initiated by wave erosion.
   1. Certain wave-cut arches.

C. Bridges initiated by solution.
   1. By seepage through a joint or other crack, thence along a bedding plane and discharging under a fall or rapid.
   2. Caving in of the roof of a cavern.

D. Bridges formed by gravity.
   1. A stone wedged in a narrow chasm.
   2. A slab separated from one bank and fallen over to the other.

E. Bridges formed by deposition.
   1. Snow and ice bridges.
   2. Travertine bridges and bridges formed by the cementation of stream bowlders which have afterwards been partly cut through by erosion.

Summary:
   1. Character of rock in which bridges occur.
   2. Stage of development of the region in which they occur.
   3. In glaciated and non-glaciated regions.
   4. Summary of origin.

Discussed by H. C. Hovey and J. W. Spencer.

Geological Suggestions Derived from a New Arrangement of the Elements: B. K. EMERSON, Amherst, Mass.

The elements were arranged in the order of the octave, two octaves and four double octaves, and interesting physical and geological relations were brought out.

New Light on the Geology of the Wasatch Mountains: ELIOT BLACKWELDER, Madison, Wis.

The past season's work of the U. S. Geological Survey in the Wasatch and Bear River Ranges of Utah, has added several facts of importance to the current interpretation of the structure and stratigraphy of the region. The Weber quartzite thins rapidly north and northwest of the type locality and there is evidence indicating that this thinning has been caused by erosion during the Pennsylvanian period. The Ogden quartzite appears to be neither Devonian, as first reported, nor Ordovician, as stated in more recent years, but merely a repetition of the lower Cambrian quartzite upon a large overthrust. The great body of "Wasatch quartzite" of the King Survey was found to be separated from the known Cambrian quartzite by a distinct although readily overlooked unconformity. Structurally the Wasatch range proves to be more than a simple monocline with local folds. Near Ogden there are several large overthrusts and a number of subsequent transverse normal faults, one of which has an unusually large displacement.

Discussed by S. F. Emmons, Bailey Willis, A. W. Grabau, Arthur Keith and the author.

Hawaiian Volcanoes: REGINALD A. DALY, Boston, Mass.

Evidence was given for the view that the vent at Kilauea is an opening in the roof of a large laccolith. This conception offers a tentative explanation of the observed independence of Halemaumau and Mokuaweoweo (Mauna Loa). A small, visible laccolith on Hawaii was then described. The paper also included a discussion of (*a*) the method by which the heat is maintained in Halemaumau; (*b*) the differentiation of Mauna Kea alkaline rocks from basaltic magma; and (*c*) the development of Mauna Kea in its present form.

Discussed by T. A. Jaggar, Jr.

Genetic Classification of Active Volcanoes: T. A. JAGGAR, Jr., Boston, Mass.

The author has studied seven active volcanoes in last eight years. Mercalli's classification by types of eruption and kinds of lavas is not genetic and hence contains many overlaps. Volcanoes show kinship of origin and stages of growth related to a common origin. It is believed that a classification based on (1) the unity of all

volcanic phenomena and (2) diversity of types measured by viscosity of lavas, will produce a rational and significant series. This series was shown in tabular form.

Tarumai, a Cumulo-volcanic Eruption in Japan, 1909: T. A. JAGGAR, Jr., Boston, Mass.

This volcano is in southeastern Yezo. It became active January 11, 1909, with culminating eruption April 12. Between April 12 and April 23, an extraordinary, hard lava dome, a phenomenon hitherto unknown in Japan, rose within the crater. The volcano otherwise is a cinder cone. Size, shape and mechanism of the dome resemble Pelée and Bogoslof. The writer visited the volcano in May, 1909, accompanied by Japanese geologists, and obtained photographs which were shown.

The discussion of Dr. Jaggar's two papers was participated in by E. O. Hovey, W. M. Davis, F. L. Ransome, R. A. Daly, Bailey Willis, F. E. Wright, Ernest Howe and the author.

The Alaskan Earthquakes of 1899: LAWRENCE MARTIN, Madison, Wis. (Introduced by R. S. Tarr.)

Severe tectonic earthquakes in Alaska in September, 1899, accompanied faulting, tilting and warping in the Yakutat Bay region. There were shocks for twenty-seven days, including five or six world-shaking disturbances and hundreds of minor shocks. On one day there were over fifty minor shocks and two world-shaking disturbances. These were recorded by seismographs throughout the world. In Alaska, Yukon Territory and British Columbia the shocks of September 3 and 10 were felt throughout an area of at least 217,000 square miles on the land, and perhaps as much as a million and a half square miles on the ocean. Only twenty thousand persons were in the area affected, two hundred and fifty close to the earthquake origin, and eight men right on one of the faults, but there was no loss of life and insignificant damage to property.

Structure of the Northern Portion of the Burning Springs—Volcano Anticline, in Pleasants, Wood and Ritchie Counties, West Virginia: F. G. CLAPP, Pittsburgh, Pa.

A careful geological examination of the northern portion of this anticline and plotting its structure on the government topographic maps shows that the anticline is not even approximately straight or of uniform height nor width, as has generally been assumed by geologists and oil operators, but is very irregular. The strike of the anticline ranges from N. 20° E. to N. 10° W. The width of its flat crest ranges from an eighth to half a mile, while the maximum altitude of any given formation on the axis varies several hundred feet in different portions of the anticline, thus making a series of alternating domes and saddles. Since the oil development here is largely a matter of the past, the relations of the oil pools to the structure can be well studied. It was found that the productive portions of the anticline correspond closely with the domes, while between these saddles were always barren of oil for distances of sometimes over two miles along the axis. As a rule the shallower oil sands are productive on an anticlinal crest, while the deeper ones are dry there, but productive farther and farther from the crest, according to relative depth.

Discussed by I. C. White.

A Generalized Section through the Appalachian Mountains of Maryland: CHARLES K. SWARTZ, Baltimore, Md.

This paper presented a generalized section through the Appalachian Mountains of Maryland, together with a discussion of certain principles of Appalachian structure. A generalized section was given through the Appalachian Mountains on the Maryland-Pennsylvania state line, with a detailed section through the central Appalachians. It was shown that there are certain principles of Appalachian structure which characterize the region discussed, and which apply to the general structure of the Northern Appalachians. The question of the origin of canoe-shaped folds was then discussed briefly. Finally, the relation of the drainage system to the structure was considered.

Discussed by Arthur Keith, A. H. Purdue and the author.

Some Instances of Flowing Wells on Anticlines: F. G. CLAPP, Pittsburgh, Pa.

Several unrecorded flowing artesian wells of a peculiar type were described. The flows are from unproductive oil wells in the northern Appalachian region. The first-mentioned instance is on the Burning Springs-Volcano anticline in Pleasants County, W. Va. This anticline consists of an alternating series of saddles and domes, and the flowing wells are situated on a saddle of the anticlinal crest situated midway between two domes. The source of the water is one of the Carboniferous sandstones, which does not rise high enough in the anticline to give the requisite head, the latter being presumably due to pressure transmitted to the water in the sandstone from overlying porous formations in the domes of the anticline. The second instance is in Beaver

County, Pa. The wells are situated high up on the flank of the Fredericktown anticline. The water comes from depths of less than 100 feet and overflows between the drive pipe and the casing of the wells, the head being due to pressure transmitted from more superficial formations in near-by hills. Analogous instances of transmitted pressure were cited from the state of Indiana.

Discussed by A. C. Lane.

Local Anticlines in the Chagrin Shales at Cleveland, Ohio: Frank R. Van Horn, Cleveland, O.

Owing to grade crossing eliminations during the preceding summer, considerable excavation has been done along the line of the New York, Chicago and St. Louis Railroad between Cedar Avenue and Mayfield Road. The rock is Chagrin shale of the upper Devonian, and many flexures, with limbs ranging from three to ten feet long, were observed. The disturbance rarely extended more than fifteen feet below the surface and passed into horizontal shale at the bottom and sides of the anticlines, indicating that the motion was of local origin. In most cases the folds are below the limit of frost action, and it is believed that they have been formed by local pressures due to the alteration of pyrite or marcasite, which are fairly constant constituents of the shales. The formation of ferrous sulphate would require a threefold increase in volume, which should cause sufficient pressure to produce the anticlines at points where the sulphides were more concentrated.

Discussed by H. L. Fairchild.

An Experimental Investigation into the Flow of Diabase: Frank D. Adams, Montreal, Canada.

A paper presenting the results of an investigation into the flow of marble was presented at the Montreal meeting. Since that time the investigation has been continued under a grant from the Carnegie Institution, the work being extended to a study of impure limestones, dolomites and various silicate rocks. The present paper presented the results of an experimental study of the deformation of a typical diabase. This deformation was carried on at various pressures and at temperatures ranging as high as 1,000° C. The resulting structures induced in the diabase are described and compared with those presented by rocks which have suffered deformation through movements in the earth's crust.

Discussed by H. F. Reid, Bailey Willis and the author.

Connate Waters of the Atlantic Coast: Alfred C. Lane, Tufts College, Mass.

In previous papers before this society, the Lake Superior and Canadian Mining Institutes, the author has called attention to the possibility of admixtures of connate (originally buried) waters in underground waters, especially in the Lake Superior region. Waters of the Atlantic coast seem also to show such admixture, sometimes of an ocean higher in calcium chloride than the present.

Changes Produced on Springs by a Sinking Water Table: T. C. Hopkins, Syracuse, N. Y.

The past two seasons have been exceptionally dry in central New York. The water table has consequently sunk lower than for many years. Besides the drying up of many springs, wells and streams, some of them have changed the kind of mineral matter held in solution. A spring at Edwards Falls, near Manlius, was a calcareous spring until last year, when it gave off considerable sulphur. This year it is giving off both sulphur and iron oxide. Another spring four miles south of Syracuse has changed from a calcareous to a sulphur spring during the same time.

Criteria for the Recognition of Various Types of Sand Grains: W. H. Sherzer, Ypsilanti, Mich.

Microscopic studies of sand grains lead to the conclusion that typical grains of glacial, beach or river, dune and desert origin may be recognized with considerable certainty. These characteristics relate to the composition, actual and relative size, shape, surface, appearance, etc., and when taken in conjunction with certain stratigraphic features may throw light upon the geological history of the sand rocks. An illustration was furnished by the Sylvania sandstone which is known in outcrop and by means of borings about the western half of Lake Erie.

Discussed by Joseph Barrell, A. C. Lane and W. M. Davis.

Climate and Physical Conditions of the Keewatin: A. P. Coleman, Toronto, Canada.

Glacial conditions prevailed at the beginning of the Huronian, but hitherto less has been known of the climate of the Keewatin. It is often referred to as essentially eruptive and with very different conditions from the present—hot seas, etc. In Ontario, where the Keewatin is best displayed, it often includes thousands of feet of ordinary sediments, not only the puzzling iron formation, but carbonaceous slate, ordinary slate, arkose, sedimentary mica schist and gneiss and crystalline limestone. The eastern Grenville series, in part probably equivalent to the Keewatin, includes similar rocks, but with far more limestone. It is essentially a sedimentary series. Most of the

eruptives of the Keewatin are surface volcanics or ash rocks. The sedimentary rocks imply land and sea, cool waters in which life existed, and in general climates and conditions like the present. As these are the oldest known rocks, there is no geological evidence that the surface of the earth was ever too hot to allow water and life to exist. Geologists and astronomers should bear this in mind in their theories.

Discussed by W. G. Miller, H. F. Reid, W. M. Davis and the author.

With permission from the society, an overture from the American Philosophical Society was then read, asking for encouragement of a plan for American exploration in the Antarctic regions.

On motion, the communication was referred to the council for consideration and report back to the society.

Then was presented:

Theory of Isostacy: W. M. DAVIS, Boston, Mass.

Discussed by H. F. Reid.

The Mechanics of Faults: HARRY FIELDING REID, Baltimore, Md.

The forces which can be considered as active in producing faults are: horizontal tensions and compressions; vertical forces (upwards or downwards) and horizontal drags on the under surface of the crust. It was shown that, in a uniform crust, horizontal forces alone would produce normal or thrust faults having hades of 45°; that the available vertical forces alone would produce normal faults with a smaller hade, and that the addition of a tension to a vertical force increases the hade, whereas the addition of a pressure diminishes it. Drags will generate pressure and tensions; they may cause faults with horizontal displacements. The elevation of large regions is due to vertical and not to tangential forces.

On the Relationship of Niagara River to the Glacial Period: J. W. SPENCER, Washington, D. C.

In the borings made in the Whirlpool-St. Davids channel, there have been discovered the remains of a cool-climate forest and soil at a depth of 186 feet below the surface, with the proof of three or four glacial advances since that time, nearly like the Pleistocene history at Toronto. Before the cool epoch, named "Forest Glen," at least two glacial epochs have left their remains in the buried channel, which is further filled a hundred feet, or perhaps two hundred, of which some of the deposits may represent a still older epoch; so that the preglacial origin of the buried gorge, requiring an enormous lapse of time (of perhaps millions of years) is indicated. The age of the modern Niagara River is also seen to be younger than the glacial deposits about the western end of Lake Ontario, though not as recent as those of the latter Wisconsin epoch in other localities.

Discussed by Lawrence Martin, F. B. Taylor, W. M. Davis and the author.

Partial Drainage of Niagara Falls in February, 1909: J. W. SPENCER, Washington, D. C.

The publication of this paper is a record through photographs taken by the writer of phenomena which may occur again. The whole of the 1,000 feet of the American Falls, 800 feet of the main cataract adjacent to Goat Island and 200 feet next to the Canadian shore (where already there had been a curtailment of 415 feet, owing to power diversion) were drained. The causes were: the permanent lowering of the basin above Goat Island by about 18 inches, since 1890; the low water of Lake Erie at the time, and strong northerly wind during very cold weather.

The Origin of Cliff Lake, Montana: G. R. MANSFIELD, Evanston, Ill. (Introduced by U. S. Grant.)

Cliff Lake lies in south central Montana about five miles northwest of the continental divide, where the latter makes the pronounced bend that partly encloses the basin of Lake Henry in eastern Idaho. The lake was brought to public notice in 1872 by Hayden, who described it as formed in a volcanic fissure. At the present time popular belief ascribes the lake to a similar origin. The paper discussed the evidence for the hypothesis of volcanic origin and presents alternative evidence to show that the lake, though set deeply in a lava plateau, really occupies a portion of a river valley that was interrupted in early maturity by the advent of a glacier which left a series of morainic dams and thereby produced a group of small lakes, of which Cliff Lake is perhaps the most notable.

Discussed by W. M. Davis and the author.

The Rock Streams of Veta Mountain, Colorado: H. B. PATTON, Boulder, Colo.

Veta Mountain is an isolated, ridge-like mountain some ten miles east of the southern end of the main Sangre de Christo Range. It stands some two thousand feet above its base and has extremely steep slopes. On the west side of the mountain are to be found two remarkable rock streams that afford excellent opportunities of studying the nature and origin of these interesting physiographic features. The streams were described in detail and their origin discussed.

Discussed by D. W. Johnson, F. E. Matthes, W. M. Davis and the author.

Meanders and Scallops: Mark Jefferson, Ypsilanti, Mich.

Meanders, or balanced swings in river courses, occur from source to mouth, though most fully developed in the plains part. The embayments or scallops produced in their upper course by meanders that come in contact with the bluff are of identical measurement with the meanders and serve to estimate the ancient volume of the stream.

Beach Cusps: Mark Jefferson, Ypsilanti, Mich.

Beach cusps are the points of gravel or sand that occur at times on almost all beaches where these materials exist. Perspective foreshortening gives them a fictitious appearance of regularity. They are caused probably in various ways, by waves that play squarely on shore, either under on-shore winds, or in still weather after storms when the diminishing waves accommodate themselves more and more to the shape of the bottom and the configuration of the shore.

Beach Cusps: D. W. Johnson, Cambridge, Mass.

This paper presented the results of studies of beach cusps found on various types of shorelines. The character and occurrence of the cusps were described. Several theories advanced by previous writers to account for the formation of the cusps were reviewed, but do not seem competent to explain the observed phenomena. An alternative theory was proposed, which receives support from the artificial production of beach cusps.

A Progress Geological Map of Oklahoma: C. N. Gould, Norman, Okla.

The paper indicated by means of charts and otherwise the work that has been and is now being done in the study of the geology of the state.

Discussed by Arthur Keith.

Salt Marsh Formation near Boston, and its Geological Significance: Charles A. Davis, Washington, D. C. (Introduced by David White.)

A description of some of the salt marshes near Boston, including newly discovered facts regarding the way in which they are formed and their bearing on geological history. These marshes have not been formed in depressions behind barrier beaches as the result of filling by plants and sediments in the resulting ponds, but have quite a different origin which is plainly indicated in their structure, and in the character of the plant material contained in them. The marshes contain easily interpreted records of a continued post-glacial coastal subsidence that is still going on at a steady and uniform rate that it is possible to determine. The interpretation of these deposits also has an important bearing on the theories of formation of coal.

Remarks were made by A. W. Grabau.

Observations on Rate of Sea Cliff Erosion: Charles P. Berkey, New York, N. Y.

The Permo-carbonic Conglomerates of South Brazil: J. B. Woodworth, Cambridge, Mass.

The bowlder-bearing Permian beds of south Brazil for which Derby proposed a glacial origin in 1888, and sagaciously likened to the deposits of India, were searched in 1908 for evidences of glaciation not previously found. Striated stones including probable fragments of disrupted glaciated flows were found in tillite beds on the Rio Jaguaricatu in northern Parana, and similar phenomena, especially striated stones, in the states of Sao Paulo and Santa Catharina. Much of the bowlder-bearing group demands floating ice at sea-level, as shown by a depauperated marine fauna between bowlder beds in the valley of the Rio Negro. Certain tillite beds seem best explained as ice-laid deposits derived from an easterly source through ice-action capable of disrupting and transporting seaward certain readily recognized rocks of the series inferior to the glacial beds. The paper as presented was illustrated by stereopticon views showing geology and topography of the area, as a part of the results of the first Shaler Memorial Expedition.

Discussed by Bailey Willis and I. C. White.

Age of the "Calciferous" Formation of the Mohawk Valley, N. Y.: E. O. Ulrich and H. P. Cushing, Washington, D. C., and Cleveland, O.

The Little Falls dolomite of the Mohawk Valley is found to consist of two distinct formations, the lower a dolomite formation of Ozarkian age, the upper a limestone of lower Beekmantown age, with a distinct unconformity between the two. The Beekmantown thins to the west so that west of Little Falls, the Lowville lies on the Ozarkian. The unconformity can be followed into the Champlain Valley, reappears in the St. Lawrence region, and is believed to mark the line of division between the two formations everywhere in northern New York. Locally, about Saratoga, a very fossiliferous limestone lens appears in the basal portion of the dolomite formation.

Edmund Otis Hovey,
Secretary

(*To be continued*)